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TRANSFORMERS.

THE papers read a fortnight ago by Mr. G. Kapp and Mr. K. D. Mackenzie at the Society of Telegraph Engineers are the first of any importance dealing exclusively with electrical distribution by the transformer system. The paper by the former author is of a specially valuable character and introduces graphic methods of calculation, always of great advantage to engineers; while the paper by Mr. Mackenzie, though containing very grave errors in theory, has a value from its dealing with the practical working of the system and the precautions to be observed in erecting conductors, &c., points upon which experience only can furnish a safe guide.

A transformer, to look at, is the simplest electrical apparatus we know. It consists of an iron ring, or its equivalent, suitably laminated or subdivided, on which are wound two coils, a primary and a secondary. Through the former is sent an alternating current of high potential, and in the latter is induced a larger alternating current of lower potential. But the laws governing the relation between the magnitudes and phase positions of these currents have been the subject of the most elaborate mathematical investigation, as witness the researches of Maxwell, Hopkinson, Ferraris and Snell. It is therefore with something approaching delight that we hail Mr. Kapp's paper and his geometrical method of dealing with a problem which treated analytically is to practical men of an extremely difficult and complicated character. As a proof of this fact we may mention that up to the present, the instances are rare in which designers of transformers have constructed their apparatus from mathematically deduced principles. Generally they have made something which "ought to be about right," and have, in fact, designed their transformers like a well-known dynamo maker designs his dynamos—with his eye. In this instance, as in most others, practice has preceded or outrun theory; but theory, now modified and corrected by practice, may be trusted to lead us with safe guidance to future work.

It is not our intention to occupy our readers' time with an abridged version of the papers read. They have appeared in our columns, and are of such a character that he who runs may read. The improvements effected in transformers during the past two years have been wonderful, though among those described we have structural differences, often of equal importance with those which a different colour of paint would give to the apparatus. There are H stampings, E stampings, and U stampings built up in endless variety, but all are modifications of the closed ring transformer of Michael Faraday. The efficiency of the apparatus is now probably as high as it can be made, and there is little to be looked for in this direction. Its self-regulating properties are excellent. Any farther improvements will therefore be in the direction of reducing the weight for a given output or of proportioning, so that the rise of temperature for a given output will be reduced. From Mr. Kapp's investigation it will be seen that the Zipernowski transformer is slightly inferior to the Gramme ring, and not superior as has been hitherto imagined.

Looking at the past we are struck with the enormous development the transformer system has undergone in half a decade. Whatever may be said of the value of Gaulard and Gibbs's patents, or whatever may be thought of the abilities of the inventors, none will deny that to the untiring energy of those two men in the face of stupendous difficulties is due primarily the progress which has been made. The exhibition of their apparatus at the Royal Aquarium in 1883 marked the dawn of a new epoch. Electricians laughed at their ideas, but they heeded not. We were amongst those who doubted the practicability of their schemes, as who were not in those early days? But now it is different. The value of a system which was, if not initiated, developed by them is fully recognised, and at this moment over 100,000 lamps are in America fed by alternating current transformers. We have said from time to time that the weak point of the system lies in the fact that with it storage is impossible and none will care to deny this. But distribution over extensive areas which is impossible with a directly-fed system, becomes possible when transformers are employed.

The early difficulties were great. Our readers will remember that when the Gaulard-Gibbs transformers were first installed at the Grosvenor Gallery the primaries were all connected in series. The lamps from the secondaries being connected in parallel the apparatus, as a consequence, could not be made to work. Various were the devices attempted with a view to get over the regulation difficulty, but none of them succeeded. As the consumer turned his lamps out, the remainder broke, and so night after night the programme of electrical misdeeds was repeated, the series system of Gaulard and Gibbs being finally abandoned and the parallel system of Ferranti substituted in its place. The folly of endeavouring to obtain constant potential from an apparatus which, having its primaries in series gave a constant current in the secondaries, was strongly censured by Mr. W. B. Esson before this,* he advising those interested to use for lighting low resistance incandescence lamps connected in series. But the Grosvenor installation was a comparatively small affair at first, and this way of getting over the difficulty would have been but temporary, as the series system is unsuited for lighting from large centres.

We agree with Mr. Kapp as to the running of the conductors and with Mr. Mackenzie as to the necessity

* ELECTRICAL REVIEW, Vol. XVII., page 157, August 15th 1885.

for spares, but we greatly fear that in some of the installations worked on the transformer system both these conditions, from what we can hear, are apt to be neglected. That there is a great future for alternating transformers we have no doubt, for they have indeed a very important present. We can only regret that the system can never give the immunity from accident which a system admitting of storage would be certain to ensure.

NOT many weeks ago we gave our readers a faint idea of the wonderfully graphic powers of description possessed by the scientific leader writer of the *East Anglian Times*. To say that he is far, far ahead of the gentleman who so ably represents the electrical columns of the London *Times*, would indeed be but faint praise, so we will let him speak for himself, merely observing that the occasion which gave rise to his remarkable utterances was a recent visit of the Ipswich Scientific Society to the works of Messrs Paris and Scott, at Norwich. The Suffolk scribe upon seeing a dynamo in motion becomes rhapsodical after this manner:—"What then happens is almost beyond description, but the magnets produce electrical currents one way, and the cylinder, technically called the armature, makes them in another direction. The rival currents as it were fight and foster one another, increasing and developing by the friction and competition. The cylinder wins the day, catches hold of the electricity and carries it away into wonderfully built up contrivances of copper and mica, called commutators. These revolve with the cylinder at a terrific speed, and give off the electricity into threads of copper bound together, technically called a brush. From the brush the electricity runs into the wire and thence to the lamp. The electricity runs into the lamp we have said, just as we say that the sun goes round the earth, but in reality, according to the savants, no fluid, current, or anything of the kind really passes. When we speak of electricity running along a wire, it simply means that the atoms of copper composing that wire are set dancing into motion, agitating and jostling one another. Inside the little electric lamp they make such a terrible excitement and agitation that intense heat is developed, and a brilliant flame produced. Mr. Gladstone and Mr. Balfour blaze into excitement sometimes in the House; it is much the same thing. Pen up a lot of energy and it must break out. When the electricity has done its work in the little egg-shaped lamp, it goes back according to theory, to the other side of the commutator—goes out one side, makes its journey of half a mile, and finishes up the other." As a specimen of newspaper science this would be hard to beat, and it is not a little curious that the previous efforts of this native of the county which bears the misnomer of "Silly Suffolk" were inspired by Messrs Paris and Scott. Not the least remarkable part of this memorable outing of the Ipswich Scientific Society, is an account of the extravagant 1s. dinner with which the members and the hungry press man regaled themselves, previous to meeting that dynamo, so that dyspepsia may perhaps be held accountable to some degree for the Ipswich journalist's doings.

WE read in *La Lumiere Electrique* that the Superior of the French Seminary in Rome has decided that absolution given through the telephone is ineffectual, since by decree of Clement VIII. (20th July, 1602) it was enunciated that corporeal presence was absolutely essential on such occasions, and also that confession by letter was inadmissible. Nevertheless the celebrated theologian above referred to (the reverend Eschbach) while firm as to the inefficiency of absolution and sacramental confession by telephone, makes a rather subtle distinction by giving priests the authority to receive by telephone the report of the state of the penitent's soul, and by the same means to exhort him to perfect contrition. It is stated that the meaning of corporeal presence admits of much latitude as witness the case of shipwrecks near the coast, when absolution is given from considerable distances, and it is pertinently asked why should not the ear be favoured equally with the eye. We may some day expect to hear even in this country that sermons brought to our ears by means of the telephone, are not invested with the same grace as when heard within a sacred edifice. This will be sad news indeed to those who through bodily affliction are incapable of attending places of worship, and who, in consequence, have incurred considerable expense in bringing their pastors' words into their own homes.

WE have received the intimation that on Monday evening the 13th inst., during the progress of the Popular Concert the electric light again went out and gas had to be substituted. A friend has suggested that perhaps Herr Joachim was playing the "Devil's Chuckle" at the moment, but in this he is mistaken. In about half an hour's time the fault was remedied and the lamps switched on. The frequency of these extinctions is really becoming a serious matter, and calculated to do very great injury to the transformer cause. On the other hand it will be a strong argument in favour of the storage system.

THE City Lighting Scheme has been "referred back." Even if nothing more serious than a protracted delay is occasioned, it is a matter for regret that the Maxim-Weston Company should, at the last moment, intervene in a business which certainly appeared to be practically settled. Particulars of the last meeting of the Commissioners of Sewers can be seen in our other pages, therefore we need not refer to details. No doubt the Anglo-American Brush Corporation can meet the arguments advanced against the use of arc lamps for street lighting, the fear that exorbitant prices should obtain, and all the other absurdities raised by certain members. The proposal of the Maxim-Weston Company, with the "patent that had only just been invented and which regulated the carbon to such an extent that there was no flickering or flaring," will bear further discussion, but we feel that by the action that company has thought fit to adopt, the progress of electric lighting will certainly suffer, whereas had the terms of the Brush Corporation been accepted, a great impetus might have been given to the electrical industry. The matter is a serious one and we invite our readers to express their views on the situation. We believe that this is not the first time in which the company, whose leading spirit is a well known M.P., has "cut in" and seriously hampered the operations of other firms. It would be well if a "cut out" could be devised which should fuse the business methods of this contracting company into something approaching fair play. Seeing that the field for electric lighting is so extensive, we fail to comprehend why it should so senselessly adopt the policy of "the dog in the manger."

THE copper syndicate seems to have captured most of the copper mining companies. We hear that the Tharsis Sulphur and Copper, the Cape Copper, and the Rio Tinto companies have already entered into agreements with the syndicate, and that the Mason and Barry company is expected to follow in the wake of the others.

TO such an extent has the influence of the copper ring made itself felt in France, that on Saturday last the matter was brought before the attention of the Chamber of Deputies in the guise of a question as to whether the Act framed against monopolies, or combinations likely to be of injury to public interests, was still in force. The reply was in the affirmative, but it is generally considered very improbable that the French Government, even with all its paternal and domestic legislation, will venture to interfere. Combinations are formed not only for raising prices but also for lowering them, and it would be difficult for a Government to stay its hand once it had been committed to interference in affairs of this nature. What guarantee would there be that in drawing the line between necessary intervention and injudicious meddling, strict justice would be always done and private interests put on one side?

THE Spanish telegraph statistics for the latter half of 1886 show the length of landlines to be 18,419 kilometres; underground lines, 144 kilometres; and submarine cables, 236 kilometres. Comparing the revenue and expenditure in 1882 with that in 1886, it appears that in the former year, with 1,675 kilometres less line, there was a considerable profit in the working of the lines, while in 1886 the excess of expenditure over revenue represents a serious loss to the administration.

AN idea may be formed of the extent to which the telephone is employed in New York, when it is stated that on one day alone 51,000 demands for communication were made, representing telephonic intercourse by 102,000 persons.

THE greater number of the German railways make use of the telephone for communications between offices, and for local service. It is principally employed on branch lines where the working of the trains presents few difficulties; but on some of the more important roads, where the simultaneous use of the telegraph and telephone was considered necessary, the employment of the former has to a great extent been reduced. 33 companies employ the telephone, over a total distance of 28,436 kilometres.

THE Gramme machine, which now supplies the current for the lighting of the theatre at Rochelle, was purchased in 1880, and employed during four years for the transmission of power in one of the first industrial applications of this kind effected in France by M. Félix, of Sermaize.

THE Electro-Technical Institute of Vienna is conducting a series of experiments upon accumulators designed by Julien, Reckenzaun, and Schenek-Farbaky (the last-named described in our issue of to-day), for the purpose of deciding as to which type presents most advantages. The last-mentioned firm has supplied accumulators to the Court Theatre for scene painting under the electric light.

IT is to be hoped that the recommendation of Dr. Hopkinson with regard to the brick trenches for running the wires at Bradford will be seriously discussed. It would be a most regrettable thing to endanger the electrical or mechanical properties of the leads by adopting any course in the nature of an experiment. We would suggest that it would not be an unwise policy to employ bare wires under certain circumstances, suspended from Johnson and Phillips's insulators. A reference to the article which we published last week on the Oerlikon transmission of power experiments will render our meaning clear.

WE find that the Leamington installation has not yet been put into thorough working order, for a correspondent informs us that at a meeting of the Town Council the other night the light went out, the City Fathers sharing the fate which we are told befell Moses. We are very anxious to learn in what part of the installation the defects have existed, and apparently still exist.

WE published on January 13th last a paper read before the American Institute of Electrical Engineers entitled "Phenomena of retardation in the induction coil," by Mr. Wm. Stanley. A discussion ensued thereon, and thinking that taken in conjunction with the papers of Messrs. Kapp and Mackenzie it might interest our readers, we have placed it immediately following the proceedings of the Society of Telegraph-Engineers.

ACCIDENTS will happen, even to so well regulated a system as that of gas supply. Last Saturday evening a man at the Canterbury Gas Works turned a handle the wrong way and instead of increasing the illumination of the city, plunged it into darkness. What a cumbrous proceeding was necessary to rectify this small error! Some hundreds of individuals must have been momentarily at work to undo the work of one. How simple would have been the process if the electric light had been the illuminant—the turning back of the handle would have put all as it was before!

THE announcement of the Central News last week with regard to the negotiations between the Government and the Submarine Telegraph Company appears to have been premature, if not incorrect. The *Financial News* seems to glory in the fact that the "Submarine shareholders are having cold water thrown over them from every quarter." Those who throw the cold water, we venture to say, would be of a different inclination were the case their own. The *Economist* accuses the company of having imposed "unduly high charges," an accusation which has not hitherto been brought against it; the proof here adduced is, forsooth, that the company has been so successful that it has been enabled to pay a larger dividend than is commonly attainable from joint-stock undertakings! Seeing what the Submarine Telegraph Company has had to contend against in past years, it seems to us unreasonable at this juncture to exclaim against its recent success, especially since those most interested, its customers, have formulated no complaint as to high charges. The argument against the desirability of allowing "a small private undertaking" to remain "the indispensable connecting link between the great State telegraph systems here and abroad" may be made quite strong enough without the introduction of false accusations tending to depreciate the value of the property of those who, though latterly well remunerated and contented, have in the past shown rare pluck and enterprise.

SNOWSTORMS.

THE past week may be said to have been a week of snowstorms, so frequent and general have they been. Happily, although the telegraph system of the Post Office, together with those of some of the railways, have not escaped unscathed, no great damage has been done. As on previous occasions, the storm of the 13th, 14th, and 15th appears to have expended its fury chiefly over a belt of country some 30 to 40 miles in breadth, extending practically between the mouth of the Severn and the Wash, following the courses of the low-lying districts or rivers. Not that the fall of snow was confined to those parts, but that those were the areas over which it told in its effects upon the various lines of telegraph. At Bristol no damage was done, and the same may be said of Bath; yet so great was the fall in the neighbourhood, that at Bristol vehicular traffic was practically stopped, the streets being loaded with some 18 inches of snow, railway traffic being only maintained with great difficulty.

The fact that most of our disastrous snowstorms—disastrous in respect of damage to telegraphs—have occurred south of the Trent, is no doubt to be accounted for by the existence of those peculiar conditions which render it possible for the snow to adhere to the wires. With wires exposed to a keen north wind and a dry atmosphere, snow falls harmlessly from them. In this case the wire is at least of as low a temperature as the snow. For the snow to cling to the wires it is necessary that their temperature should be something above that of freezing. As the snow falls upon them in this condition it melts, but if the air is chilled with the storm the film of water formed upon the wire by the melted snow soon becomes ice, and thereafter the snow as it falls clings to it, and the existence of the line of telegraph is then merely a question of the duration of the storm, its violence, and the strength of the line. Lines passing through humid districts—low-lying lands, as water meadows, the banks of rivers, or the neighbourhood of trees—are always open to casualty from snowstorms, because whereas in the open the air is of that coldness and dryness which usually precedes snow, in these districts there is a trifling degree of greater warmth accompanied by less dryness. This it is which probably accounts for the effect of snowstorms being usually more evident in the area which is comprised within the points previously named.

If this is so, then the lesson gained is to strengthen our telegraph lines which pass through such districts. Time was when poles were never stayed, but that which was once the rule is now the exception, and staying, more or less, is now a recognised necessity. The stability of a line of telegraph depends mainly upon everything being kept taut. If the stays of a line are not such as will resist the strain brought to bear upon it, casualty is nearly sure to follow. Of course we are quite aware this cannot always be assured with the material employed and the locality in which lines have to be erected. A single line of poles may often be run where a double pole line would not be permitted. It is probable many of our single pole lines might be built stronger; poles might be placed closer together, and wire, stranded by machinery, used for staying instead of the hand-made stays so generally employed. The latter class of stay must always prove defective under heavy strains. However apt the workman may be, it is practically impossible for him to lay on each wire so that it shall take its proportion of the strain. With a light line, consisting of four or five wires, this is not so serious a question, but with a full line, consisting of 20 to 25 wires, too much care cannot be taken nor too good material employed. Staying wire, whilst requiring a certain amount of ductility, should have a high tensile strain (say, 1,800 lbs. for No. 8), and very little stretch. Elongation is not desirable in a stay. The ductility should be sufficient to enable it to be layed around the stay rod loop. Five such wires stranded by machinery would give a breaking strain of 9,000 lbs., or, say, two tons; and two such stays ought, if well and judiciously applied, to resist any pressure brought to bear upon them by a snowstorm. At all events, the employment of such should place the strength of the pole beyond that of the line wires where the spans exceed 80 yards. Another precaution which might with advantage be pursued is that of staying every fifth or tenth pole laterally, *i.e.*, in the direction of the line. The object of this is to prevent the poles running back, as is usually the case when the wires break or a pole comes to grief. This is, we have observed, carried out by one or two of the larger railways in districts where the line of telegraph is much exposed. We would recommend its general adoption on all heavily-wired lines.

It will be clear that in the end we may so strengthen our poles that whilst they stand the wires will become broken. This is so; still we think it will be found advantageous to do so. Broken wires are more easily repaired than broken poles. We may also strengthen our wires by shortening spans. This naturally will reduce the insulation, and on that account is not desirable as a rule; still, applied to special localities, it will probably be found admissible. It is hardly possible for us to dispense with open lines of telegraphs, and this being so, all we can do is to consider and seek to meet as fully as possible their weak points. Snowstorms are their bane. As a rule the damage arising therefrom is not throughout the area of the storm, but is limited to the existence of certain peculiar conditions, as we have explained. Extra precautions in the construction and upholding of the line in these localities will, we have every reason to believe, be found to aid their integrity. Good timber, well planted, careful and strong staying, and wires renewed before being allowed to degenerate in size, are the points to be commended.

DESIGNING ELECTRIC MOTORS.*

By FREDERICK WALKER.

THE electric motor has now become a recognised article of practical utility, and has graduated, as it were, from a mere toy to an important commercial factor. There are, in the market, motors *and* motors, but yet we find in practice that for each and every particular application there exists certain stringent conditions which render it necessary to design a special electric motor that will fulfil the requirements of the particular application, even if a certain modicum of the theoretical 90 per cent. of efficiency has to be sacrificed.

The writer, among many other instances, may quote, as an example, the numerous experiments conducted by himself when designing and carrying out the construction of the first two or three electric locomotives of the set that are at present running daily on the tramway between Stratford and Ilford, belonging to the Elieson Electric Locomotive Company. In this case the special requirements were a low speed and a short field magnet, and, of course, the weight had to be reduced as much as possible, the latter condition being a *sine qua non* where electrical traction is concerned. Before dealing with such experiments in detail it will be well to consider the best practical method of arriving at the proportions of the car case, and the proper winding of a motor to suit the exigencies of electrical traction.

Taking an ordinary tramway car, weighing $1\frac{3}{4}$ tons, carring 40 passengers, the united weight of whom is 2 tons, and allowing $1\frac{1}{2}$ tons for 60 accumulators with an electric motor and accessories, the total weight that has to be propelled along the tramway track, at the regulation rate of speed of 7 miles per hour, is $5\frac{1}{4}$ tons. Upon an ordinary level track, under favourable conditions, the mean tractive force required should be

* This article has been awarded the prize in the competition instituted by the *Mechanical World*, from which journal it is reproduced.

about 26 lbs. per ton, therefore, since the maximum speed is

$$\frac{7 \times 5{,}280}{60} = 616 \text{ ft. per minute,}$$

and the load is

$$5{\cdot}25 \times 26 = 136{\cdot}5 \text{ lbs.,}$$

and the actual horse-power absorbed during the run at this rate of speed is

$$\frac{136{\cdot}5 \times 616}{33{,}000} = 2{\cdot}5 \text{ H.P.,}$$

and adding the loss due to friction of the speed, reducing gearing, &c., at a rate of 15 per cent., the total becomes 2·87 H.P.

When ascending a gradient of, say 1 in 80, the power absorbed is proportionately greater, for the tractive force becomes

$$\frac{2{,}240}{80} = 28 + 26 = 54 \text{ lbs. per ton,}$$

and the total power required to maintain the former speed of the car up the incline is

$$\frac{5{\cdot}25 \times 54 \times 616}{33{,}000} = 5{\cdot}2 \text{ H.P.,}$$

and since 1 in 80 is a comparatively light gradient it serves to illustrate the range of actual mechanical force that is required in order to drive an ordinary tramcar along a variable track. In designing the motor and gearing, there must not be a single pound weight of surplus material, as every pound of dead weight requires nearly 8 foot-pounds of energy in order to propel it at a speed rate of 7 miles per hour on a level road. Now, in order to overcome the *vis inertia* of the loaded car, that is, start it from a position of rest, requires an approximate tractive force of 78 lbs. per ton, or a total of 7·7 H.P. representing the necessary initial force required. Suppose that there exists upon the track no gradient steeper than 1 in 80, and the weight of the loaded car and its accessories is 5¼ tons, and that we have to provide a motor or motors wherewith to drive it at a speed of 7 miles per hour, the maximum power required is, as we have seen, 7·7 H.P., but to which we must add the power absorbed by the motor, and also by the gearing. If the latter be properly adapted it should absorb but 15 per cent., and the motor should at least possess 70 per cent. of efficiency when running at its critical speed. Now the maximum electrical horse-power that has to be exerted for about one minute, while overcoming the *inertia* of the car, is approximately 8,300 watts, and the discharging E.M.F. of the accumulators is about 1·98 volts, the available E.M.F. from the 60 cells is 118·8 volts, and the maximum current is 69 ampères. Upon this data, therefore, we may begin to calculate the dimensions of the motor, remembering, however, that although 70 per cent. is a low efficiency for an electric motor, and that it is possible to construct one to absorb about 9·5 per cent. of the electrical energy, it is only in very exceptional cases where the latter would be applied for the requirements of electrical traction. An ordinary tramcar wheel is 30 inches diameter, or 15 inches from the rail to the centre line of the axle. The floor of the car must not be raised above the centre line more than 16 inches, and allowing 4 inches for clearance at the bottom and top, the motor cannot exceed 22 inches in diameter over the pole pieces. In practice, however, we should find that an armature 15 inches in diameter would perform the necessary work, and assuming that we use bent wrought iron field magnets of the shape usually known as Siemens's, the iron core would be 1⅝ inch in thickness, and each magnet core 14 inches in length, and the width 10 inches, of course corresponding to the armature, which will be 10 inches in length over all when wound. Now we know that the initial and maximum running current, C^1, is 69 ampères, and that the initial E.M.F., E, at the terminals is 118·8 volts; therefore the resistance, r, of the motor will be deduced from $C^1 \times 1{\cdot}35 = 93{\cdot}15$, being the current, C, that will pass through the motor when it is absolutely stationary. The resistance, r, will be, therefore, $\frac{118{\cdot}8}{93{\cdot}15} = 1{\cdot}2$ ohms.

Now, any coil or coils of wire revolving in a magnetic field must have a potential generated in it or them, therefore, as the motor in question is to run at a reasonable speed to suit the intermediate gearing, say 650 revolutions per minute, a counter-electromotive force, e, is set up in the wire tending to check the flow of current from the accumulators, because it is acting in an opposite direction. The counter-electromotive force, e, in this case will have a value of about 85 volts, and therefore from the above data we may estimate the theoretical efficiency of the motor.

The current absorbed when the critical speed is attained is—

$$\frac{E - e}{r} = C,$$

and this represents the maximum efficiency when the motor is performing most work and absorbing least electrical energy. Substituting the known values in this equation we get—

$$\frac{118{\cdot}8 - 85}{1{\cdot}2} = 28 \text{ ampères,}$$

so the values of the varying current in ampères are as follows:—

$C = 93{\cdot}15$ ampères standing still,
$C^1 = 69{\cdot}00$ „ moving slowly.
$c = 28{\cdot}00$ „ critical speed.

Now the proportion of energy utilised as tractive force and the energy actually absorbed by the motor is represented by the fraction

$$\frac{e}{E}, \text{ or substituting the values,}$$

$$\frac{85}{118{\cdot}8} \text{ or 71 per cent. efficiency.}$$

I am of opinion that the counter-electromotive force, e, of a motor is analogous to the expansion of steam in a steam engine cylinder, with regard to its economical results, for we see at once that the most effective and economical electric motor would be one in which the values of the E and e were nearly equal. This would mean a high rate of speed per yard of armature conductor, and since in the present case such a speed is not admissible, the result could only be obtained by largely increasing the diameter of the armature. This is likewise impossible, because of the limited space occupied by the motor and gearing, and under any circumstances a motor possessing a high degree of efficiency is too heavy and cumbersome for application to tramway traction. Taking into consideration the enormous additional weight of a motor of 90 per cent. efficiency, and the power absorbed in transporting such a weight, it has been found more practicable to employ a lighter motor with a less commercial efficiency. There have been of late years several patents taken out, based upon Froment's bar armature, solely with a view to obviate what the inventors chose to consider a serious disadvantage, viz., counter-electromotive force. The efficiency of such a motor must, of course, depend upon the single statical pull of the field magnets upon each bar in succession, therefore the current absorbed must be enormous in proportion to the mechanical work done upon the spindle.

I have found in practice that the best armature core is one built up of a number of segments, forming a perfectly circular ring, each layer of which is carefully insulated by the interposition of sheets of paper soaked in shellac varnish, and the whole taped over ready for winding as a Gramme ring. The wire must be chosen of sufficient sectional area to carry the maximum current for a short time without becoming unduly heated, and the length of the armature conductor must also be proportionate to the counter-electromotive force, e, that is required, and the resistance between the brushes, or, to put the matter plainly, the resistance between two opposite segments of the commutator, is

best when about 0·55 of the total resistance, r, which has been established by calculation. The commutator should be divided at least into 60 parts, and should possess a good bearing surface for the brushes, in this case at least 5 inches clear, for it must be borne in mind that the tangential contact of the brushes is exceedingly fine when the commutator is perfectly circular, and also that an electric motor, unlike a dynamo generator, receives the current upon the commutator suddenly, the greatest current, of course, passing when the motor is at rest, and is required to move. The end bearings should be long, so that the intervening film of oil shall not be driven out by centrifugal force when the motor is running, and also in order to distribute the pressure of the rotating spindle over as large a surface as possible. Every opportunity should be afforded for the free ingress of air around the revolving armature, so that the temperature may be reduced as much as possible.

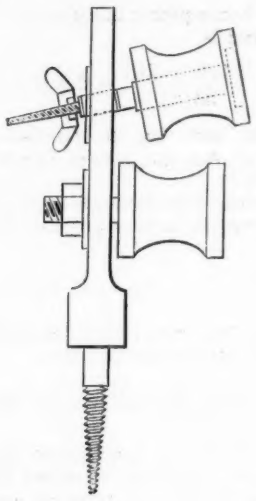
There are many methods that have been employed with more or less successful results of varying the speed of an electric motor when applied for the purpose of traction. Resistance coils are frequently arranged so that they may be interposed in the circuit by means of a multiple switch at will. This method is exceedingly wasteful, as the reduction of speed in the motor is accomplished by the absorption of a proportionate amount of the electrical energy in heating the resistance coils. Another method is to cut a number of accumulator cells out of the circuit, and so reduce the E.M.F. This is not practicable, because the accumulators are then unequally discharged, and there is a corresponding waste of energy during the process of recharging. I have found in practice that it is better to arrange a compound switch so that, in the case of a single motor, the field magnet connections could be varied at will. Where two or more motors are employed it is an easy matter to arrange a circuit, governed by a proper switch, so that the motors may be run singly, in series, multiple, or multiple series. An essential point in a motor for purposes of tramway traction, or for electric launches, is a simple method of reversing the motion. This may be done by means of a duplicate set of brushes, or by reversing the direction of the current around the field magnets; or special differential gearing may be interposed between the motor spindle and the work.

Without doubt the time is approaching when electrically propelled tramcars and boats will be no longer isolated cases, but will be among the common sights of every-day life upon every river and in every large town in the kingdom, and engineers will be as familiar with the electric motor, in theory and practice, as they are at present with the steam engine.

A NEW CARRIER FOR LINEMEN.

LINEMEN who have struggled with tangles, knots, and crosses in telegraph and telephone wires, will recognise at once the utility of the simple little tool illustrated in the accompanying cut, which is an outline view showing the manipulation of the tool. For this and the description we are indebted to the *Western Electrician*.

The tool or carrier, as it is termed, was designed for stringing or taking down wires, but it will prove particularly valuable in replacing old wires on telegraph poles with new wires, as where a large number of wires are strung on the same pole it is a difficult job to replace any or all of them, as they have to be cut at frequent intervals, and involving tangles without number and resulting naturally in crosses. By the use of this tool long stretches of wire can be put up or taken down or replaced with new in a very expeditious and rapid way. The device consists of a standard provided at the bottom with a gimlet-point screw. On an axis at right angles to the standard are two sheaves, between which the wire is designed to run. The upper sheave or roller, by means of the thumb-screw shown is adjustable, and permits the roller to be so extended as to allow the insertion of the wire between the rollers; this is plainly shown. When using the tool the lineman goes from pole to pole, screws a carrier into the cross arm next each glass insulator of the line to be renewed, and detaching the wire places it between the two sheaves; the new wire is then attached to one end of the section of old wire, and by pulling at the other



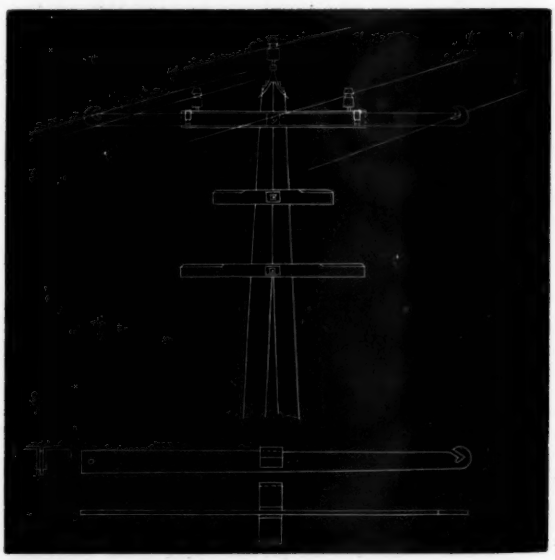
end of the section the old wire is readily drawn out, while at the same time the new wire is drawn into place. The lineman then ties the new wire to the insulators, removes his carriers, which are then ready to be used on another section.

Wires can be taken down or strung in the same way, the chief point being the very great reduction of friction by the use of the carriers.

The Western Electric Company, of Chicago, is preparing to introduce these useful tools to the trade.

GILBERT'S REVERSIBLE LEVER FOR THE RENEWAL OF TELEGRAPH AND TELEPHONE WIRES.

THE ordinary method of renewing wires on telegraph poles consists in simply drawing the wire over the arms. This method, however, unless carefully done is



very liable to cause continual interruptions by the new wires sagging down on those below them. Mr. Gilbert's invention is designed to obviate these annoying inter-

ruptions. The arrangement, which is shown by the figs., consists of a lever which is supported in rather a novel manner; the lever is made of $\frac{1}{2}$th inch steel, and easily sustains the weight of a man.

The wire is first run off the drum on the ground for say a quarter of a mile, and then lifted on to the levers and drawn moderately taut, after which the old and the new wire change places, and when connection is made the old wire is cut and falls clear of the wires below, so that no interruption whatever can possibly occur.

ON THE DIFFERENCE OF PHASES OF CURRENTS, ON THE RETARDATION OF INDUCTION, AND ON THE DISSIPATION OF ENERGY IN TRANSFORMERS. EXPERIMENTAL AND THEORETICAL RESEARCHES.

By Prof. GALILEO FERRARIS.

(*Continued from page* 157.)

But in the case of our experiments and in general in the cases which are encountered with induction apparatus constructed to serve as secondary generators in their applications, the difference observed between the equations (18) and (19) and (8) and (9) may be converted into a study of the first approximation with which we have been occupied. In the induction apparatus which are constructed for practical application, the relations $\frac{\lambda_1'}{\mu_1}$ and $\frac{\mu_2'}{\mu_2}$ are both approximately equal to the relation between the number of the turns of the secondary coil and that of the primary. The two ratios are therefore equal between themselves, and we have

$$\frac{\lambda_1'}{\mu_1} = \frac{\mu_2'}{\mu_2}. \qquad (20)$$

But if this equation is satisfied the formula (17) gives

$$\theta' = \theta$$

and

$$\frac{\lambda}{\mu} = \frac{\lambda_1'}{\mu_1} = \frac{\mu_2'}{\mu_2}. \qquad (21)$$

In the case, therefore, of the experiments which form the object of this memoir, the spirals made of thin plates and all equal, were in equal number in the two coils, those of the one alternating with those of the other. Not merely the condition (20) is found verified with a very close approximation, but we have with the greatest approximation

$$\frac{\lambda_1'}{\mu_1} = \frac{\mu'_2}{\mu_2} = 1.$$

The experiments have demonstrated, as it has been seen, that $\frac{\lambda}{\mu}$ must be approximately equal to 1·009 and have in this manner justified our prevision. It is further necessary to remark that the terms of the equation which are affected by θ and θ' are themselves very small. On account of these considerations we may retain $\theta' = \theta$.

But if we introduce this value of θ' into the equations (18) and (19) these are reduced to (8) and (9) of the foregoing paragraph from which (I.′), (II.′), (III.′) are deduced.

In this manner the existence of the retardation θ and its relations to a, b, c to which we have been led by the considerations in the foregoing paragraph are re-discovered by means of the consideration of the Foucault currents. Besides, we have in the equations (15) and (17) relations useful for a more minute interpretation of the phenomena.

The equations (17) give the values of μ, of λ and of θ in functions of μ_1, λ', μ_2, μ_2', λ_2, ρ. And on these relations some observations present themselves.

The first observation relates to the retardation due to the Foucault currents.

From the two first formulæ (17) we have by division

$$\tan \frac{2\pi}{T}\theta = \frac{\mu_2'\,\mu_2\,\rho}{\mu_1\,(\lambda_2^2 + \rho^2) - \mu_2'\,\mu_2\,\lambda_2}$$

If $\rho = \infty$ this expression gives

$$\tan \frac{2\pi}{T}\theta = 0.$$

since when $\rho = \infty$ the Foucault currents do not exist and therefore there can be no retardation due to them. If ρ is not infinite but very great, $\tan \frac{2\pi}{T}\theta$ is positive and small, and as both for $\sin \frac{2\pi}{T}\theta$ and for $\cos \frac{2\pi}{T}\theta$ the formulæ (17) give positive values the value of θ is here also positive and very small. With the gradual decrease of ρ, θ goes on increasing. Practically we can make ρ vary and diminish gradually by constructing the core at first of insulated iron wires of a very small diameter and then of wires of a diameter greater and greater; and experiment shows that effectively the values of $\sin \frac{2\pi}{T}\theta$ correspond to a similar value of ρ becoming gradually greater.

The second observation relates to the values of μ and of λ. For $\rho = \infty$ the equations (17) give $\mu = \mu_1$, $\lambda = \lambda_1'$; but if setting out from the value ∞ ρ is gradually caused to diminish, the values of μ and of λ become suddenly less than μ_1 and λ_1' and go on gradually diminishing. This fact also finds a confirmation in the results of our experiment.

We must lastly note that although the equations (17) and the expressions for μ, λ, θ obtained from them contain neither the intensity of the two currents, primary and secondary, nor the resistance, r, of the secondary circuit, yet, in fact, such resistance affects the values of μ and of λ and of the retardation θ. In fact, the hypotheses made in writing the differential equations (10), the hypotheses that M_1, L_1, L_1', M_2, M_2', L_2 are constant is approximately true only when the iron is far from the condition of magnetic saturation. In reality all the coefficients of induction decrease with the increase of the intensity of the magnetisation. Hence they decrease with the increase of A and of B, and for a given value of A they decrease with the increase of r.

As the magnitudes, μ, λ_1', μ_2, μ_2', λ_2, on which depend the values of μ, λ, θ obtained from the equations (17) are inversely proportional to the duration, T, of the period of the alternative currents, so we have already seen that the values of λ, μ, θ determined experimentally by the use of alternating currents should, with one and the same transformer, result differently, according to the number of inversions which the current employed undergoes in each unit of time. This observation, which all the experiments confirm, extends evidently to cases in which it is desired to determine the coefficients of induction by means of experiments with alternating currents and of calculations made with the incomplete formula (1).

Section 6.

Dissipation of Energy; its Relation to the Retardation, θ, and to the Magnitudes, a, b, c, directly measured in the Experiments.

14. The causes of the retardation, θ, whether they are phenomena of the Foucault currents, or of instance, or of both together, give also place to a dissipation of energy. Between the dissipation of energy and the retardation there exists a simple relation. This relation is independent of the cause of the one or the other, and we can find it by means of the differential equations (5) and (6), in writing which we have certainly admitted the existence of a retardation, θ, but we have suggested no hypothesis as to its cause.

For this purpose it is sufficient to observe that the energy dissipated is equal to the difference between the work supplied by the electromotive force, e, and that which is restored in the form of heat in the primary and secondary circuits. Now the work done in the element of time, $d\,t$, by the electromotive force, e, is

$$e\,i\,d\,t,$$

whilst the work transformed into heat in the two circuits is

$$(\mathrm{R}\,i^2 + r\,i'^2)\,d\,t.$$

Then the energy dissipated in the time, $d\,t$, is

$$(e\,i - \mathrm{R}\,i^2 - r\,i'^2)\,d\,t$$

that dissipated during an entire period, T, is

$$\int_0^{\mathrm{T}} (e\,i - \mathrm{R}\,i^2 - r\,i'^2)\,d\,t$$

and that dissipated on the mean in each unit of time is

$$\mathrm{P} = \frac{1}{\mathrm{T}} \int_0^{\mathrm{T}} (e\,i - \mathrm{R}\,i^2 - r\,i'^2)\,d\,t \qquad (22)$$

Now the equations (5) and (6) of section 4 give

$$e\,i - \mathrm{R}\,i^2 = \mathrm{M}\,i \left(\frac{d\,i'}{d\,t}\right)_{t-\theta} + \mathrm{L};$$

$$\left(\frac{d\,i}{d\,t}\right)_{t-\theta'} - r\,i'^2 = \mathrm{M}\,i'$$

$$\left(\frac{d\,i}{d\,t}\right)_{t-\theta} + \mathrm{L}\,i' \left(\frac{d\,i'}{d\,t}\right)_{t-\theta}$$

whence:

$$e\,i - \mathrm{R}\,i^2 - r\,i'^2 = \begin{cases} \mathrm{M}\left[i\left(\frac{d\,i}{d\,t}\right)_{t-\theta} + i'\left(\frac{d\,i}{d\,t}\right)_{t-\theta}\right] \\ +\mathrm{L};\left(\frac{d\,i}{d\,t}\right)_{t-\theta} + \mathrm{L}'\,i'\left(\frac{d\,i'}{d\,t}\right)_{t-\theta} \end{cases}$$

If in this expression we substitute for i, i',

$$\left(\frac{d\,i}{d\,t}\right)_{t-\theta}, \left(\frac{d\,i'}{d\,t}\right)_{t-\theta}$$

the values

$$i = \mathrm{A}\sin\frac{2\pi}{\mathrm{T}}(t-a),\ i' = \mathrm{B}\sin\frac{2\pi}{\mathrm{T}}(t-\beta),\ \left(\frac{d\,i}{d\,t}\right)_{t-\theta}$$

$$= \frac{2\pi}{\mathrm{T}}\mathrm{A}\cos\frac{2\pi}{\mathrm{T}}(t-a-\theta),\ \left(\frac{di'}{d\,t}\right)_{t'-\theta} = \frac{2\pi}{\mathrm{T}}\mathrm{B}\cos\frac{2\pi}{\mathrm{T}}(t-\beta-\theta),$$

and then introducing all into (22), and executing the quadrature we find:—

$$\mathrm{P} = \frac{\pi}{\mathrm{T}}\left[\mathrm{A}^2\mathrm{L} + \mathrm{B}^2\mathrm{L}' + 2\,\mathrm{A}\,\mathrm{B}\,\mathrm{M}\cos\frac{2\pi}{\mathrm{T}}(\beta-a)\right]\sin - \frac{2\pi}{\mathrm{T}}\theta \qquad (23)$$

or, likewise:—

$$\mathrm{P} = \frac{\pi}{\mathrm{T}}\left[\mathrm{A}^2\,\mathrm{L}\,\mathrm{L}' + \mathrm{B}^2\,\mathrm{L}'^2 + 2\,\mathrm{A}\,\mathrm{B}\,\mathrm{M}\,\mathrm{L}'\cos\frac{2\pi}{\mathrm{T}}(\beta-a)\right]\frac{1}{\mathrm{L}'}\sin\frac{2\pi}{\mathrm{T}}\theta.$$

It may be observed that if we call n and n' the number of turns in the two coils of the transformer, and if we represent by k a constant we have, at least with a close approximation,

$$\mathrm{L} = k\,n^2,\ \mathrm{L}' = k\,n'^2, \text{ whence } \mathrm{M} = k\,n\,n'.$$

But if we make use of the notations

$$\frac{2\pi}{\mathrm{T}}\mathrm{M} = \mu,\quad \frac{2\pi}{\mathrm{T}}\mathrm{L}' = \lambda$$

$$\frac{2\pi}{\mathrm{T}}(\beta - a) = \phi$$

the final expression for P may be written:

$$\mathrm{P} = (\mathrm{A}^2\mu^2 + \mathrm{B}^2\lambda^2 + 2\,\mathrm{A}\,\mathrm{B}\,\mu\,\lambda\cos\phi)\frac{1}{2\lambda}\sin\frac{2\pi}{\mathrm{T}}\theta.$$

Now, the equation (II.) of the eighth section of section 4 gives

$$\mathrm{A}^2\mu^2 + \mathrm{B}^2\lambda^2 + 2\,\mathrm{A}\,\mathrm{B}\,\mu\,\lambda\cos\phi = \mathrm{B}^2 r^2,$$

whence

$$\mathrm{P} = \frac{\mathrm{B}^2 r^2}{2\lambda}\sin\frac{2\pi}{\mathrm{T}}\theta. \qquad (24)$$

If we call Q the mean quantity of energy evolved in each unit of time in the entire secondary circuit we have:

$$\mathrm{Q} = \frac{\mathrm{B}^2 r}{2},$$

whence

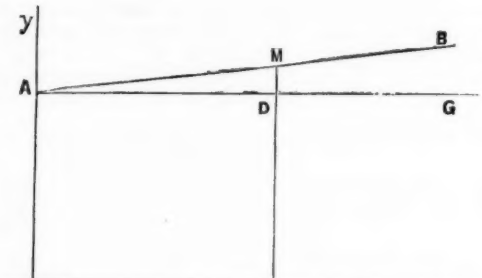
$$\frac{\mathrm{P}}{\mathrm{Q}} = \frac{r}{\lambda}\sin\frac{2\pi}{\mathrm{T}}\theta. \qquad (25)$$

This formula expresses a notable relation between the retardation, θ, and the corresponding dissipation of energy, a dissipation which in a well constructed transformer is practically the most important, and is the only one which has to be considered.

15. Combining this relation with (III′.) of section 4 we get

$$\frac{\mathrm{P}}{\mathrm{Q}} = \frac{\mu}{\lambda}\left(\frac{c}{b} - \frac{\lambda}{\mu}\right); \qquad (25')$$

and thus we see how the relation between the energy dissipated and the energy produced in the secondary circuit may be combined with the quantities c and b which are measured directly in our experiments and may be calculated by means of the same.



We have seen that if in a system of Cartesian co-ordinates the values of the resistances, r, of the secondary circuit are plotted out as abscissæ, and as ordinates the corresponding values of $\frac{c}{b}$ derived experimentally, we obtain a line, A B (fig. 2), which cuts the axis of the ordinates at the point, A, of the ordinate $\overline{\mathrm{O\,A}} = \frac{\lambda}{\mu}$ and that as the abscissæ increase, it deviates progressively from the axis of the abscissæ, O x. If we draw through the point, A, the right line, A C, parallel to the axis, O x; the ordinate, E M, from any point, M, of the line, A B, cuts the right line, A C, at a point, D, and we have

$$\overline{\mathrm{D\,M}} = \frac{c}{b} - \frac{\lambda}{\mu}$$

whence, according to (25′)

$$\frac{\mathrm{P}}{\mathrm{Q}} = \frac{\overline{\mathrm{D\,M}}}{\mathrm{E\,D}} \qquad (25'')$$

In other terms the energy dissipated is to the energy produced in the secondary circuit as the segment, D M, is to the segment, E D. Or again, if we represent the energy produced in the secondary circuit by E D, the energy dissipated is represented by D M.

(To be continued.)

ELECTRICAL ROTARY MOTIONS.

FOR many years I have been dissatisfied with the explanation given in text books of the electrical rotation apparatus devised by Faraday.

From the explanation given in text books, one would be led to believe that the moving conductor rotates round its pivot with an even circular motion. But this is not the case.

If a conductor shaped as in fig. 1 is pivoted at *p*, and caused to rotate in a trough of mercury surrounded by a coil of wire, then the following phenomenon will be observed :—On the closing of the circuit, first of all the elbow, *e*, is bent forward so as to bring the current in the conductor more nearly parallel to the current in the coil, the coil then attracts the moving conductor towards itself until *c* breaks contact with the mercury. The conductor, *c*, *e*, then tends to assume a perpendicular position, and in doing so the end, *c*, is moved forward a little before it falls on the mercury again. On the circuit being completed by the conductor touching the mercury the operation is again repeated.

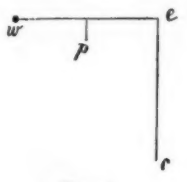


FIG. 1.

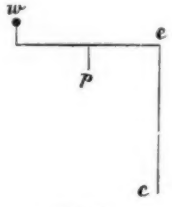


FIG. 2.

If the moving conductor is a heavy one and a strong current is used, then these separate operations are nearly indistinguishable, and the conductor appears to rotate evenly and to be continually in contact with the mercury of the trough.

But by counterbalancing the conductor by a weight as shown in fig. 2, each of these separate motions of the conductor are made distinctly discernible. First the elbow, *e*, dips to put the current in the coil and conductor more nearly parallel with each other, then the conductor is attracted towards the coil until *c* breaks contact with the mercury, and finally as *c*, *e* becomes perpendicular the conductor is moved through a certain angle before it again touches the mercury. In fact when the conductor is so balanced by the weight, *w*, that *c*, *e* only has a slight tendency to remain perpendicular, the conductor rotates around the pivot by a series of leaps.

If, instead of using a small coil around the trough, a larger coil, say of six inches height, is used, so as to surround the whole length of the moving conductor, then the separate operations by which the conductor is rotated become still more distinguishable and the conductor may be made to rotate around its axis with such leaps that it only touches the mercury once or twice each revolution.

If the finger be placed against the elbow, *e*, so as to prevent the conductors from rotating, then the end, *c*, will leap off and fall on to the mercury in a rheotomic manner. But the distance that the end leaps off the mercury is not so great as the deflection of the elbow, *e*, if the end, *c*, is held.

There is a strong resemblance between these electrical rotary motions and that of a gyrostat supported on one axis only and rotating around its point of support in an horizontal plane.

The motion of a gyrostat thus supported is of course due to the joint action of its rotation round its axis, and to gravity. In a like manner it would appear that electrical rotary motion is due to the action between the moving conductor and the coil being opposed by the action of gravity. That gravity plays an indispensable part in all electrical rotary motions seems obvious, since none of these motions take place in other than an horizontal plane.

W. MOON.

ONE OF THE CAUSES OF THE INEFFICIENCY OF THE REIS TELEPHONE.

SOME who have experimented with the Reis telephone, says Prof. A. E. Dolbear in *Science*, declare that they have never been able to hear a transmitted word. Others have heard some words and sentences ; but these have always been weak and irregular, so as generally to discourage one in a short time, especially now, when through the improvements in telephones it is possible to reproduce words both loudly and regularly. Experimenters therefore have been impatient with Reis's apparatus, and seldom have done anything with it, except make some hasty tests for some phase of the great telephone controversy.

The inefficiency of the Reis telephone has, by a kind of common consent, been admitted to be altogether due to the imperfect mechanical operation of the transmitter, by which the making and breaking of the current when it is in operation is such as not to properly follow the actual vibratory movements of the diaphragm when the latter is moved by speech-vibrations ; that at best it can deliver to the line only the fundamental rate of the vibration, leaving out the characteristic overtones which are supposed to be necessary to the successful transmission of speech. This judgment as to the mode of operation of the transmitter has been derived wholly from what has been heard by one listening at the receiver ; for there is to-day no known method by which it may be determined whether or no a transmitter has the proper motions, except by listening at the receiver. That is the test. Hence it has been concluded, that if speech was not properly delivered in a receiver, the trouble must be with the lack of proper movements of the transmitter. Yet it is mechanically possible for the transmitter to move properly, and the receiver to be so much overloaded, so to speak, that the latter fails to be heard on account of the extra disturbance.

The Page effect—the magnetic click—may be so strong in a Reis receiver, with a proper current, as to be heard a good many feet distant from it. When the receiver is held against the ear, the sound may be very loud ; so much so as to quite drown weaker sounds, if they happen to be present. Especially when these loud sounds occur 50 or 100 or more times per second, the effect is that of continuous sound ; and as the persistence of hearing is something like the tenth of a second, it follows, *a priori*, that such rates of vibration as from 200 to a 1,000 per second might be present, yet too weak to be heard in the presence of such overpowering sounds that have an appreciable persistent effect. These loud magnetic clicks are heard only when there is a sudden break in the current in the receiver. If, then, some way can be devised for preventing these extraneous sounds in the receiver without interfering at all with the transmitter or its "mode of operation," one may experimentally determine whether the Reis transmitter does or does not act mechanically so as to vary the current in correspondence with speech or other sound vibrations. I therefore conceive, that, if there was a short shunt circuit between the terminals of the transmitter, some of the currents would traverse the coil of the receiver the whole time, no matter whether the circuit through the transmitter was open or closed. The loud clicks would be suppressed without interfering in any way with the "mode of operation" of the transmitter ; and, if the latter really did follow the motions of the diaphragm, the variations in the current strength would correspond, and the speech would be heard. This I found to be truly the case ; for with a transmitter thus provided with a shunt circuit of about two ohms, which could be switched in or out with a key, it was at once possible to hear a large part of what was spoken when the shunt was in ; when it was out of circuit, the sounds were generally inarticulate.

This experiment is an *experimentum crucis*, and proves that the inefficiency of the Reis telephone is much more due to the extraneous sounds in the receiver than to the lack of appropriate motions of the platinum terminals of the transmitter. It proves that the trans-

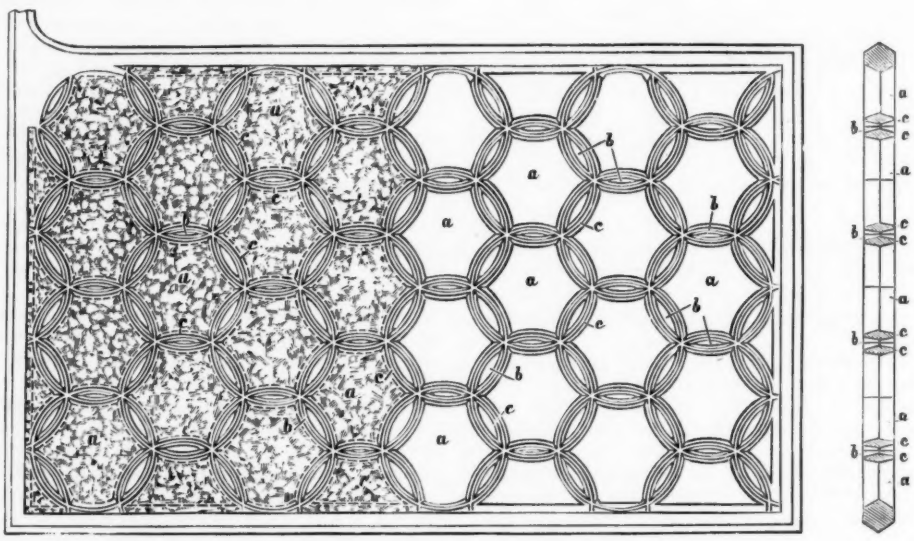
mitter does and must always have worked in the proper mechanical way, and that the current theory of its mode of operation is not correct. It proves, too, that when carbon is substituted for the platinum terminals, there is an improvement in efficiency, but not in its mode of operation.

FARBAKY AND SCHENEK'S ACCUMULATOR PLATES.

THE object aimed at in these plates is so to construct or manufacture the latter that the active material does not expand so as to break the frames. The material used does not fill up the lead frame, but is divided by gaps or holes which may be conveniently arranged so as to form regular divisions in the grating. By means of this improvement the durability of the plates or elements, and consequently that of the accumulator, is claimed to be greatly increased.

The cause of the gradual destruction of the lead frames of the plates, under ordinary conditions, is that the active material increases in volume to a considerable extent, although slowly, and by continually expanding and stretching the frame produces cracks or flaws in the latter. When the protecting crust of crystalline oxide of lead breaks away from the lead, the sulphuric acid or electrolyte and the electrolytically generated ozone obtain free access to these cracks, and this occurs after a time at numerous places, so that the continuity of the lead frame is ultimately broken and its conductivity destroyed, the plate or element finally falling to pieces. This is prevented in Messrs. Farbaky and Schenek's plates by employing in place of gratings formed by straight bars crossing one another a frame formed by intersecting rings or divisions forming polygonal spaces for the reception of the active material with gaps or spaces between, which are unoccupied. Fig. 1 is a side elevation and fig. 2 a transverse section of the new form of plate or element, in which it will be seen that the rings, *c*, forming the grating are so arranged that polygonal spaces at *a* are formed for the reception of active material, the spaces at *b* being left empty.

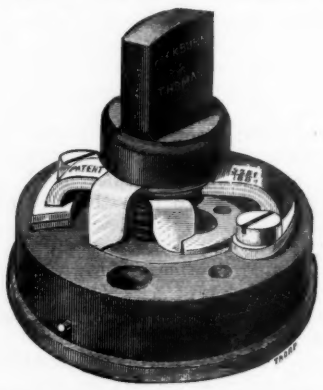
In this form of construction the augmentation in volume of the active material takes place without injury to the plate or element, as the unoccupied spaces, *b*, permit of the expansion of the contents of each space, and the divisions are not stretched but rather compressed, so that the frame as a whole undergoes practically no alteration in its form, and is thereby protected to a considerable extent from deterioration. It will be evident that the divisions may be of other shape than circular, provided that there are the spaces for the active material with unoccupied spaces between.



THE COCKBURN-THOMAS SWITCHES.

WE have had sent us samples of a new switch, which appears to be one of the best we have seen. The inventors, Messrs. Cockburn and Thomas, claim for it perfect locking combined with a very rapid break of contact when breaking circuit.

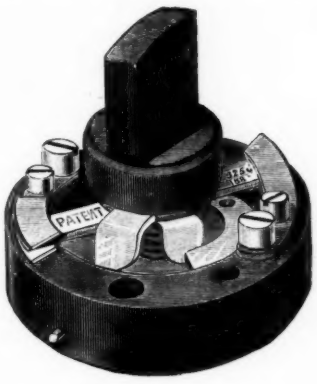
The principle is based upon the contact bar being free to move, independently of the rate at which the handle is turned, the bar being quite separate from the handle. Round the spindle is fitted a strong spiral spring, one end of which is securely fixed to the brass base plate, the other end is fastened round a pin fixed on the movable contact bar; this spring keeps the contact bar in the "off" position, but the main feature or improvement in this switch is a device for firmly holding or locking the bar in the "on" position. This is accomplished by means of a special spring fitted to the base plate, and so arranged that when the contact bar has been moved to the "on" position the spring rises and catches against a projecting pin or flange placed upon the contact bar, and so holds the bar firmly in the "on" position against the force of the spiral spring before mentioned.



In breaking circuit the first action is to unlock the contact bar or release the pin from the holding spring, to do which, a special projection or flange is attached

to the handle, so arranged as to depress the spring and set free the locking catch. Directly this is done the contact bar being free to move, and also having the full force of the coiled spring acting upon it, flies quickly off the fixed contact pieces and allows no time for a destructive arc to form. By this arrangement it is impossible for the bar to remain partly "on," but must be either locked in the "on" or held firmly in the "off" position.

Two forms have been sent us. Type A in which the contact bar is made up of a number of strips rivetted together, their ends bearing upon the contact plates,



the other, type B, in which the contact bar is solid and passes into contact clips.

Messrs. Cockburn and Thomas inform us that they have another form in which arrangements are made for absolute locking, both in the "on" and "off" position, and of which we hope to give a full description later on.

AMERICAN NOTES

By "DAS TELEPHON."

IN electrical matters, the most important is the trial before the Commissioner of Patents on motions made by M'Donough and Gray to re-open the interference case between those parties and Bell and Edison, decided March 3rd, 1885. This trial began on 1st and ended on 9th inst., and was conducted by eminent counsel, ex-Senator Conkling and Storrow for Bell, Col. Ingersoll and Mr. Hurd for M'Donough, and Casey Young for Gray.

The case was closed yesterday, and I send to the REVIEW a condensed report of the arguments by Col. Ingersoll for M'Donough, which I think will be very interesting to your numerous readers.

It here followeth :—

Col. INGERSOLL said: Mr. Commissioner, according to my idea the first thing to examine or the first point that should be settled is whether or not the evidence that was before the Examiner, and the evidence that was before the Examiners-in-Chief, and the evidence that is in this motion, absolutely show and establish beyond a reasonable controversy the fact that the Reis telephone, as invented by him, will speak. The importance of that is pertectly manifest from the further fact that McDonough claims an improvement on that system, so that the question is, will the Reis telephone talk; was it intended to be and was it a speaking instrument? When that fact is established the field is opened for anybody to patent any device connected with the transmission and receiving of speech. It seems to me that there can be no dispute as to that one fact. The invention of Reis was a telephone. He gave it the name. He made it for that purpose, and, according to testimony, he succeeded. He accomplished his object. First, as to whether the Reis telephone will talk. Upon that subject I first call your Honour's attention to the affidavit of Prof. Nipher, the Professor of Physics of Washington University, who states without the slightest hesitation that the instrument known as the Reis telephone will speak; that it will transmit articulate speech. He also says that there is no essential difference between the undulatory, pulsatory, and intermittent currents. The operation of the instrument of Reis does not differ in any way from the operation of the modern transmitter now in use. The fact that Reis made so many different types of instruments containing the same elements which modern practice has shown to be essential is positive proof that he had the art of telephony clearly and correctly in his mind. The transmitters of Reis contain every essential element of the modern transmitter, and there can be no doubt that he constructed the instruments, as he says. This man took the Reis instruments that were deposited in the Smithsonian Institution at Washington, and his affidavit says that when he put them together in exact conformity with the directions of Philip Reis they talked—that articulate speech was transmitted. He simply says that it works. He was speaking through these instruments, words were transmitted, words were received. Can that be said of an instrument ever made by Mr. Bell up to February 14th, 1876? Can it be said of any instrument or device made by Mr. Bell, or even drawn by Mr. Bell up to 1877? It is very much easier for a man to make a machine talk who wants it to talk than for one who puts up a machine and adjusts it, having in his mind the firmly fixed prejudice that it is deaf and dumb. In spite of himself he will work for the corroboration of his theory, for the justification of his prejudice. You know as well as I that the instruments at that time—1861 and 1862, or in 1864—were extremely crude, and what the parts lacked in mechanical nicety had to be compensated for by precision of adjustment.

The COMMISSIONER: I understand the other side to say they think that there are, now and then, certain conditions that make the instrument equivalent to a microphone, and that a word would escape the Reis invention.

Mr. INGERSOLL: I understand that point, and it is the easiest thing to destroy that little rampart of nonsense that has been put in front of the Bell invention. Everybody will admit—everybody in the world, including the gentlemen on the other side—that the office of the receiver is to reproduce what has been produced. Now if the transmitter invented by Reis will not so affect the electrical condition of the wire, or to use other language, will not impress voice waves or sound waves upon the current of electricity, then no receiver could give out human speech, because the receiver can only take what is given it, and unless the invention is such that it sends the composite wave, that is to say, a wave representing a pitch or quality, tone or form—the receiver cannot take and reproduce such a wave. I will show before I get through, even by Mr. Cross, that this transmitter of Reis will convey speech to the receiver invented by McDonough, and will itself give articulate speech to the listener at the receiving end. I do not believe the history of the world will give such a record of intellectual impudence as this case. They stand now before you, and without changing complexion say that Reis made a stumble that he didn't know what he was doing; that all he did was to stub his toe upon a hidden fact in nature; that his only intention was to produce and reproduce musical tone. That was all, and yet Reis himself says he laboured with a view to producing the total actions of all the organs apparent in human speech. Suppose, gentlemen, that had been in Bell's fifth claim, how easy, how much easier the task would have been! You cannot, from his patent of March 7th, 1876, show, you cannot raise a suspicion, that he had a speaking telephone in his brain, and I hope to show before I get through that he didn't. But suppose these words had been there:—"I propose at one time to produce the total action of all organs apparent in human speech, my object being to convey speech at a great distance by means of electricity and of the devices that I describe." If that had been in Mr. Bell's fifth claim would anybody have had the impudence to say that he was not thinking about a telephone? Would anybody say, then, that he had stubbed his toe on a hidden fact in nature? Now, then, if all these witnesses swear, the witnesses who have tried it, witnesses who have demonstrated it, that the Reis instrument will talk, and Reis's object is to produce speech, and the evidence is that he succeeded, what right has anybody to say that this is an error, that this is an idea not born, still lingering in the womb of time? When we take into consideration the state of the art at that time the devices of Reis are simply marvellous. Can there be any doubt upon this one question? If this decision, made by the examiners in chief, is based upon the assumption that the Reis instruments will not transmit speech, then they are in error, and their judgment should be set aside. Now we have proved two things. First, the transmitter talks with the Reis receiver; it talks better with the Bell receiver. It talks with a better transmitter, but the transmitter and receiver as constructed by Reis will transmit articulate speech. When you talk to it so loudly that it refuses to transmit, it is not an infringement of Bell's claims. When you talk to it softly, so that speech is transmitted, then you violate Bell's claims. In other words, the absolute question is whether Bell's patent rests on the difference of tone. If you speak loud, they say, it does. Here comes Mr. Bell and says: "I have got the theory. True, I had no machine; I had no device except a fragrant odour of expectation blowing like a broken cloud in my brain; but I have got the theory. You have got to have an undulatory and continuous current." "But," says another, "I can break it many thousand times a second." "Well," replies Mr. Bell, "If you break it too often it becomes continuous, and then you infringe." The Reis instruments will speak, and I say now I am willing to risk the entire case and everything connected with it upon the simple question: "Will this instrument that I now touch (referring to the instrument on the table) transmit articulate speech?" and I may say beyond a doubt it is an exact facsimile of the Patent Office model and it will transmit speech. Yet that is the instrument that won't talk. That is the instrument that has the impudence to fly in the face of a theory of Prof. Cross. That is a fact that just stands right up and denies a

theory; and you can imagine the impudence it takes in a fact to do a thing like that, especially a Western fact, in the presence of an Eastern theory.

Among other reasons for demanding a new trial Mr. Ingersoll declared that when the motion was submitted to Commissioner Butterworth he distinctly stated that if he found that he had to decide it against the Bell people he would send it to his successor.

I came from New York to hear this celebrated case, and did not miss one word uttered by any of the counsel, and I am of opinion that the present Commissioner will be very reluctant to re-open the case which has been adjudicated by the Primary Examiner, the Examiner of Interference, the Board of Examiners, and by two Commissioners; but the universal outcry against the Bell monopoly might have an effect on him to induce him to order a new trial, so as to avoid the suspicion, so long prevalent, that the Bell Telephone Company is intrenched behind a triple plating of that metal against which "the strong lance of justice hurtless breaks."

Washington, *February* 10th, 1888.

THE ELECTRIC LIGHT IN BRADFORD.

DR. HOPKINSON has now issued his report upon the electric lighting scheme for Bradford. It appears that of the two sites available for the generating plant—one in Bolton Road and the other at the junction of Godwin Street and Sunbridge Road—he has no hesitation in recommending the one in Bolton Road. With regard to the system of lighting, he points out that for central station lighting a variety of systems are available, and after explaining some of them, he says:—"We are, then, reduced to the ordinary direct system of distribution. This system presents the advantage that a continuous current is used available at pleasure for charging accumulators or for transmission of power. The direct system may be applied in two ways—either the simple two-wire system or the three-wire system. The latter enables a double potential to be used with the same facility for turning out the lights singly, and it is specially adapted to distribution at such a distance that the mains on the two-wire system become costly, but that it is still not wise to introduce transformers. In the present case, comparing with the two-wire system, the three-wire system would save about 12 per cent. of the electrical power, with a proportionate saving in the cost of engines and dynamos. It would also effect a considerable saving in the cost of conductors. I have, therefore, no hesitation whatever in recommending its application in the present case. At the same time the distance is not so great that the two-wire system is wholly inapplicable, and if the engineer in charge of the work has a strong preference for postponing the introduction of the three-wire system I would not advise that his responsibility should be diminished by insisting upon its immediate introduction." Dr. Hopkinson adds that the patent for the three-wire system in this country is his own, and that the committee might, therefore, make such allowance as it thought fit for any possible bias on his part in its favour. If the site in Bolton Road, with its extensive area, were selected, then he would advise the use of Lancashire boilers, with Galloway tubes. Precisely the same consideration would apply in this case as would apply to the boilers for a mill. He thinks that the Lancashire boiler would be adopted for a mill by practical men without the slightest hesitation. With regard to the steam engines, he says that the primary question is—Should the dynamo machines be driven direct with a separate engine to each machine, or should they be driven by belts or ropes from engines running at a slower speed? Dr. Hopkinson considers that a separate engine for each machine is best. Referring to dynamo machines, he says he would incline to the use of five, delivering about 50,000 watts each at the lamps; but, at the same time, the use of a smaller number of larger machines would be perfectly successful, and would possess certain advantages over the larger number of smaller machines. It is very important, he says, that the amount of the electrical supply produced by the machine should be as high as possible, and adds that machines have been built which convert 93 per cent. of the mechanical work applied into electrical work useful outside of the machine. The contractor for the dynamo machines should undertake to give the Corporation a commercial efficiency of at least 90 per cent. Speaking broadly of the system of laying the cables, he points out that there is the choice of three systems. First, the Corporation might use armoured cable—that is, cable protected on the outside by a sheathing of iron wire; they might use pipes of earthenware or iron, or they might lay the cable in brick trenches. Dr. Hopkinson expresses the opinion that the brick trenches would be the best. With regard to the method of charging, he asks is the Corporation to charge by meter or by special agreement with customers? "It is," he says, "very much more costly to store electricity than to store gas, consequently you must provide a plant competent to meet the maximum demand. A consumer, then, who takes his supply for half-an-hour at the time when the demand is a maximum, will cost you as much as a consumer who takes the same supply during seven or eight hours, provided those hours are the hours when the demand falls short of the maximum. You must keep your machinery running, and the only difference between running with a fair load and light is a small addition to your coal bill. Again, although there are many meters which will measure electricity, they are more or less costly, and sufficient time has not yet elapsed to test them for wear and tear. . . . I should therefore, advise at first, at all events, that you should charge by agreement with the customer. The basis of this agreement should be the maximum which the customer will take. You would put an instrument upon his service main which would cut him out if he seriously exceeded his maximum." With regard to the hours of work, Dr. Hopkinson considers that it would be best to begin by running from a little before sundown until perhaps one or two o'clock in the morning. The hours could be extended to an extent justified by the demand. In his judgment, the Corporation should not undertake the fitting up of houses for the electric light; but it should keep the most absolute control over the way in which the wiring was done.

The recommendations given above—which are practically the same as Mr. Shoolbred's, with one or two exceptions, notably the wire system—will in all probability be adopted by the Corporation. No efforts have been spared to obtain the best system extant, and in order to see the practical working of installations, several members of the Gas Committee visited London and Leamington last week, and the result of the visit was that they were confirmed in the opinion that they were about to adopt the best known system for lighting the town. Mr. Shoolbred is proceeding with the plans and specifications, some of which are in an advanced stage. It is hoped that in a week or two the specifications will be placed before the committee, and tenders will then be advertised for. The committee will advertise in detail, with the hope that it may be able to have the work begun and completed, if possible, by one firm of contractors. Among the leading features of the proposed installation will be its absolute safety and its simplicity. It is intended to have the work done in such a way that whatever improvements may be found necessary may be made at any time.

THE TRAGIC HISTORY OF AN INVENTION.

OUR readers are familiar with the details of the assassination of M. Raynaud by a man named Mimault, who imagined that the rejection of an invention of his was due to the personal influence of M. Raynaud. In a recent number of *La Lumière Electrique* is a long account of the events which led up to the tragedy referred to; possibly a condensed version of the story may be of interest.

In 1874 a telegraph *employé* named Mimault invented a multiple transmitting telegraph instrument which required the use of five wires. Mons. Raynaud, at that time entrusted with the examination of telegraphic apparatus, advised Mimault, on the instrument being presented for examination, that there was no chance of its being accepted since it in no way showed an advance in invention. Later on in the same year Mimault returned to Paris with a multiple transmitter using one wire, but the Administration would not make use of this apparatus as it was not considered any improvement on the Meyer instrument then in use, and which fulfilled some of the conditions required.

In the same year M. Baudot, who had been working for some time on a multiple printing transmitter, brought his invention before the notice of the Adminstration. Mimault about this time having announced that he had invented a similar apparatus, was invited in 1875 to bring his invention before the Administration. This he would not, or could not do, so the Baudot system was ultimately adopted. Mimault then brought an action against Baudot for infringement of patent, but the first trial was indecisive. In 1880 the case was again brought before the Paris Tribunals, and judgment was delivered against Mimault. In 1883 this decision was annulled, and the case taken before the Amiens Court of Appeal, which in 1884 decided against Mimault. The Administration in order to avoid further litigation gave a sum of 8,000 francs to Mimault, who, however, took the affair before the higher court at Amiens, where in 1885 the decision of the Court of Appeal was confirmed. It appears that at various times during this litigation Mimault had altogether received about 20,000 francs, besides retaining his salary and position as an *employé* in the telegraph service. Mimault's final demands upon the Adminstration, after losing all his actions, were:—The payment to him of 100,000 francs, the Cross of the Legion of Honour, the prolongation of his patent rights, his advancement to the grade of engineer in the service, the adoption of a new instrument he had invented. The Administration refused these demands, but offered Mimault the use of its workshops for the elaboration of the instrument he was designing. This reply was signed by the Director-General, and it has been clearly proved that poor Raynaud had nothing whatever to do with the inventor or his inventions beyond having at the very first advised Mimault that his original scheme was of no value.

Our contemporary comments very severely on the folly of giving liberty to a monomaniac like Mimault, after his having committed the offence of discharging his revolver among a lot of school boys on the chance of a bullet finding its billet in the body of the son of M. Cochery, the then Minister of Telegraphs.

ELECTRIC LIGHTING IN THE CITY.

At a meeting of the City Commission of Sewers, held on Tuesday, at which Mr. W. H. Pannell presided, the Streets Committee brought up a report submitting for adoption an amended arrangement with the Anglo-American Brush Electric Light Corporation for lighting a district of the City by means of electricity. The district to be lighted commenced from the front of the Royal Exchange, and comprised so much of the City as lies between the Poultry, Cheapside, St. Paul's, Ludgate Hill, and Fleet Street on the north, and Queen Victoria Street and the Embankment on the south.

Mr. J. C. Bell, in moving the adoption of the report, referred to the previous connection of the Commission with experiments in electric lighting in the City. In 1878 they tried the Jablochkoff system, at an expense of seven and a-half times the cost of gas, but, as far as they could judge, it failed. In 1881-82 they entered into contracts with three companies for experimentally lighting the City at the same time, to test which was the better system. The Brush Company charged for works, installation, and lighting in the district allotted them £1,410, or twice the cost of the gas there, but the light gave 15 times more illuminating power. The Lontin system cost £2,930, or four times the cost of gas, the illuminating power being 14½ times greater; and the Siemens system cost £3,720, or 3¾ times the cost of the gas in the district allotted them, the illuminating power being 13½ times greater. They afterwards entered into a contract with the Edison Company for lighting a part of the City with incandescent lights. None of these systems or experiments gave satisfaction. The terms of the present proposed contract with the Anglo-American Brush Company were double the price of gas in the same area—viz., £4,394 instead of £2,200—but they would get 32 times the amount of light. It was contemplated to use 196 arc lamps of 2,000 candle-power each, at a cost of £26 per annum each. The Committee had selected the most frequented parts of the City for the experiment, but if it proved a success, there would be no difficulty in extending it throughout the City. He believed the contract was not only a fair one, but virtually a one-sided one in favour of the public. They had had complaints from many quarters of the insufficiency of the lighting in the City, but any increase in the number of gas lamps would be very expensive. Electric lighting would not only afford a greatly better light, but would minimise the risk of fire, and tend to the protection of property. The cost would necessitate an increase of one-eighth of a penny in the pound on the ratable value of the City, of which about one-fifth of the whole area would be lighted by electricity. To those who had any experience of the atmosphere of the large establishments of the City, where hundreds of workpeople were employed—such as the printing offices—the advantage to health by the introduction of the electric light would be patent. While it was proposed to make a contract for a term of seven years, any failure of the company to observe its provisions would not only bring about its immediate cancelment and the forfeiture of the deposit of £1,000, but would inflict on the company the loss of the monopoly of private lighting, so that in its own interest the company would take care to have no failure. The whole of the installation was to be finished by October, 1889, but they hoped to have the City lighted street by street as the work progressed. The company would have, as far as the Commission could grant it, a monopoly of private electric lighting in the district, but they could not compel the inhabitants to use it, and it was, therefore, to their interests to make the charges as low as possible in order to secure orders and to compete with the gas supply. The same monopoly of lighting was now given to one gas company, with the result that the cost of public street lighting was decreased. In the present case it was estimated that each arc lamp in the streets would cost £40 per annum to the company, which it would, therefore lose £14 on each lamp; but would bear this loss for the sake of the monopoly of private lighting. If the experiment proved successful they might go to other companies and get better terms, and if it were a failure they could fall back upon the gas, besides making the company pay for the failure. It had been suggested that the Commission might undertake the work more economically and just as efficiently themselves, or, at all events, that they should have a right of pre-emption of the shares of the company, but as electric lighting was still in its infancy, he thought that at this period they had better let other people, who understood the work, do it. He contended that arc lighting was the proper mode of illuminating a city such as London, and observed that the contract contemplated the provision of shadowless lamps, and of glow lamps in the smaller streets. He believed that if the work was carried out as proposed the Commission would be entitled to the thanks of the community. At all events, they would be likely to bring the gas companies to their bearings. Even that small agitation had had the effect of reducing the price of gas by 6d. per 1,000, and he hoped that sooner or later the gigantic gas monopoly would be broken down. For these reasons he urged the Commission to adopt the report.

Mr. C. T. Harris, as an amendment, moved that the report should be referred back for further consideration. He argued that the present lighting of the City, as far as all practical purposes were concerned, was perfectly sufficient, and that anything further would be merely a luxury, for which the ratepayers should not be called upon to pay an increased tax. He objected to the report on four grounds—viz., because arc lighting was unsuitable for the purpose; because the illuminating power could not be adequately estimated, and was, therefore, enormously exaggerated; because the cost was prohibitory, and because he considered the terms of the contract open to grave criticism in the interests of the public. On these grounds he begged the Court to give the matter further consideration.

Mr. J. E. Sly observed that four or five years ago a great deal of money was spent by the Commission in experiments with the electric light. It was hardly for the Commission to contemplate lighting one portion of the City at the expense of the other. They had shown their desire for the light by the large sum of money they had spent in experiments. If they contemplated adopting the electric light it ought to be for the whole City. The Maxim-Weston Electric Light Company would supply the electric light to the whole City for £15,000 for the first cost fitting, &c., and £3,875 a year for maintaining the light—800 lamps of 450-candle-power each being supplied. This would pay itself in two years. He asked them to reconsider the matter, so as to get it done in the cheapest way they could, and not to have a seven years' monopoly.

Mr. Bridgman referred to the insufficient manner in which the City was lighted as compared with the Holborn District, and observed that he did not know a more dismal place than the neighbourhood of St. Paul's at night. The electric light had been adopted in New York, Brooklyn, Paris, Vienna, and some towns in England.

Mr. Morton said he was strongly in favour of getting the electric light, but they did not want to be entrapped.

Mr. J. V. Moore supported the amendment. He referred to the improvements which had taken place in gas lighting, and observed that gas was becoming a formidable rival to the electric light. A new lamp had been brought over from Berlin which gave a wonderful light at a consumption of only twelve feet of gas per hour. The Court could not, consistently with its duty, agree to the report, and it ought to be sent back for further consideration.

Mr. L. H. Phillips and Mr. G. Shaw also supported the amendment, while Mr. Deputy Scott warmly advocated the adoption of the report.

After some further discussion the amendment was declared to be carried on a show of hands. A division was demanded, with the result that the amendment was carried by 36 to 17. The report was accordingly referred back for reconsideration.

REVIEW.

Electrical Instrument Making for Amateurs. By S. R. Bottone. London: Whittaker & Co., Paternoster Square, E.C.

This book will be very welcome to many amateurs who cannot find sufficient information to satisfy their requirements in the pages of the "Every Boy's Book" and like publications. The instructions given are usually very minute, and ought to amply satisfy most people; but in several instances, as is usually the case, directions are given which, although apparently very easy to carry out, present points of difficulty which may prove stumbling blocks. Thus the amateur is told that it is easy to construct a soldering bit out of a copper wedge with an iron rod fixed into it. Now we undertake to say that the amateur may hunt half over London and yet will be unable to get a piece of copper such as the author mentions; a complete copper bit could be purchased without difficulty, but a piece of unwrought copper it is no one's business to sell. Any amateur taking up Mr. Bottone's book and making the various pieces of apparatus described in it, will have served a very good preliminary apprenticeship for the profession of an electrician. All the apparatus described are more than mere toys, and serve to illustrate well the general principles of electricity. There is certainly plenty of room for works of the kind, as they fill a gap which exists between very elementary and advanced books, and moreover they teach amateurs how to handle tools, a most important branch of technical education.

Lighting of Buoys by Electricity.—Lieut. Willis, of the U.S. Lighthouse Department, has lately carried out some very successful experiments on the lighting of buoys by incandescence lamps, supplied by means of cables from the shore. One lamp of 30 candle-power was fixed in each buoy. The Government is so satisfied with the results of the experiments that it has ordered a considerable length of cable for the purpose of extending the trials.

LEGAL.

The Faure Electric Accumulator Company, Limited v. Phillipart.—Queen's Bench Division. (Before Mr. Justice Hawkins.)—In this case the liquidator of the Plaintiff Company, which was being wound up, claimed to recover from Mr. Simon Phillipart, a former director of the company, £70,459 for calls in respect of shares. The amount was made up as follows:—A first call of £1 made in November, 1882, on 22,532 ordinary shares of £10 each, standing in the name of the defendant, and forfeited in January, 1883; a second call of the same amount made on the same shares in December, 1882; two calls of £1 each on 2,000 ordinary shares standing in the joint names of defendant and Mr. E. L. Broubenge, together with interest at the rate of 10 per cent. in accordance with Articles of Association.—The defendant denied his liability on a variety of grounds, asserting that the shares were held by him as trustee of a Belgian Company entitled the Société La Force et la Lumière; and the Plaintiff Company, being well aware of the circumstances, had agreed that the shares should be forfeited, on the terms that neither defendant nor the Belgian Company should be liable for either calls or interest. The Belgian Company assisted, it was said, in promoting the Faure Company, and paid £50,000 in cash on the shares, and the arrangement was, it was contended, because of the large cash payment, that forfeiture should be a discharge of all liability. In regard to the second call the defence was that it was invalid, as it was made at a board meeting attended only by two directors instead of a quorum of three, as required by the Articles of Association. Further, defendant contended that he had ceased to be liable because he had been bankrupt in France, and the liquidator had recognised the bankruptcy. On behalf of the plaintiffs, however, it was contended that defendant had not been discharged from liability, and it was denied that the bankruptcy had been recognised. As to the second call, it was said the quorum should, according to the Articles of Association, consist of three until otherwise determined, and in April, 1882, the board resolved that two directors should form a quorum.—Mr. Channell, Q.C., and Mr. Grosvenor Woods appeared for the plaintiff; and Mr. Finlay, Q.C., Mr. Henderson, and Mr. Merrick represented the defendant. —At the conclusion of the arguments, his Lordship said the matter was of some nicety, and he would take time to consider his judgment.

King, Brown & Co. v. Anglo-American Brush Electric Light Corporation.—(Before Lord Trayner.)—The record was closed last Tuesday in an action brought by King, Brown & Co., Rosebank Electric Works, Broughton Road, Edinburgh, against the Anglo-American Brush Electric Light Company, 6, York Place, Edinburgh. Declarator is asked that defenders, claiming to be patentees of or asignees to and proprietors of the invention described in letters patent dated in January, 1882, and amended in February, 1885, have, by letters and otherwise addressed to pursuers in September, 1885, August, 1886, and December, 1887, threatened pursuers with legal proceedings in respect of the alleged manufacture, use, or sale of the alleged invention, said by defenders to be covered by the letters patent, and interdict is asked of defenders continuing to make these threats. Damages to the amount of £1,000 are also asked. Pursuers say they have for some time carried on a considerable business in making and selling electric machinery of various kinds suitable for lighting buildings, ships, &c., and that defenders have in their letters threatened legal proceedings in respect of an alleged infringement of, in particular, compound wound dynamo machines, and that they have, by letters and advertisements, sought to prevent pursuers' customers and the public from dealing with pursuers on the ground that the machines pursuers were supplying were an infringement of their letters patent. These have, it is said, seriously interfered with and injured pursuers' business. They have, they say, invited defenders to institute legal proceedings, but they have failed to do so. Defenders say that their registered office is in Lambeth, London, that they have only an agency in Edinburgh, and that the matters complained of in the action had nothing to do with the business carried on in Edinburgh or in Scotland. They claim to be the registered owners of a patent which secures to them the rights of manufacturing, using, or selling dynamo machines for electric lighting and other purposes in which the process of compound winding is employed, and they admit writing the letters complained of, but say that they contained no threat of legal proceedings. They admit writing in December last stating that unless an arrangement were made proceedings would be taken for infringement of the patent, and they say they received a letter in reply stating that pursuers were not making any machines for which defenders were entitled to exact royalties. They say that they have since discovered compound winding dynamos, which were supplied by pursuers on one of the Orient Line steamships, and that they have instituted proceedings against the Orient Steam Navigation Company in respect of these machines. They plead that they have no domicile in Scotland, and that in respect of the action against the Orient Company the action is incompetent.

NOTES.

The Electric Light in Barcelona.—The contract for the lighting by electricity of the Paseo Isabel II., the Plazo del Palacio, and the Paseo de la Aduana, in Barcelona, was offered to public tender on January 14th ultimo. It appears that only one tender was presented, that of the Sociedad Espanola, and to this company the contract was adjudicated.

Electric Lighting in Paris.—The Municipal Council of Paris has voted one million francs for the establishment of a central electric light station for lighting certain portions of the city, and is at present considering the question of the system to be adopted, the points to be illuminated, and the method of canalization. Meanwhile we see announced the formation of the Paris Electric Light Company, which proposes to undertake the lighting of the Communes of Asnières, Bois Colombes, Colombes, and Courbeovie.

The Electric Light in Venice.—We learn from the columns of a contemporary that there exist three electric light installations in Venice, distributed as follows:—1. The Public Gardens; supplied with 27 arc lights of 6 ampères, and 200 incandescence lamps of 16 candles, the motive force being of 40 horse-power. The installation cost 55,000 francs. 2. The Lido; supplied with 24 Siemens arc lights of 9 ampères, and 240 incandescence lamps of 10 and 16 candles. The installation cost 40,000 francs. 3. Giudecca; supplied with 106 Siemens incandescence lamps, 24 of 35 candles, 56 of 25 candles, and 26 of 10 candles, the motive force being of 15 horse-power. The installation cost 19,500 francs.

The Electric Lighting Act.—Mr. Barclay had given notice to ask in the House of Commons last night in how many cases the powers obtained by Provisional Orders under the Electric Lighting Act of 1882 have been actually exercised; why so little progress has been made with electric lighting under the Act of 1882; and whether the Government intends to amend the Act, with the view of encouraging the development of electric lighting.

The Suez Canal and the Electric Light.—From a paper read by M. Lemonnier before the International Society of Electricians, we extract the following table of the number of vessels making use of the electric light for the passage of the Suez Canal at night:—

From December, 1885, to 1st March, 1887	1887. March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.	
26	15	19	18	16	17	24	22	22	24	26	229	Vessels carrying their own electric light plant.
...	...	...	1	4	4	4	12	11	18	20	74	Vessels hiring electric light plant from Messrs. Bazin and Co.
...	...	...	...	5	6	7	11	16	20	29	94	Vessels hiring electric light plant from Messrs. Worms Josse & Co.
26	15	19	19	25	27	35	45	49	62	75	397	

The above-named firms supply electric light plant when required, charging £10 for apparatus and staff during the passage.

Electric Light in Belgium.—The Edison Société Phœnix has installed the electric light in the Ghent Theatre. Besides 200 incandescence lamps of 10 candle-power and 140 of 20 candle-power, there are several arc lights employed for stagic effects. The current is supplied by an Edison dynamo of 70 volts and 300 ampères, running at 700 revolutions per minute.

The Electric Light at the Adelaide Exhibition.—The electric light installation at the Adelaide Exhibition comprises 145 arc lights and 266 incandescence lamps. The 11 dynamos supplying the arc system are of the Brush pattern, 10 being of 8,000 watts and 1 of 6,000. The latter-mentioned machine has an ingenious commutator, by means of which the current can be regulated to 10 ampères at 600 volts, or to 20 ampères at 300 volts. The incandescence lamps are supplied by 3 Victoria dynamos, each of 8,000 watts, 1 Edison-Hopkinson machine of 7,800 watts, and 1 Edison dynamo of 5,000 watts. The total length of cables amounts to 8 miles, and the circuits are so arranged that no department is dependent on one circuit only.

Exeter and the Electric Light.—On Tuesday evening a largely attended meeting of the inhabitants of Exeter was held at the Victoria Hall, for the purpose of hearing a lecture by Mr. C. J. Wharton, of London, on "Electricity as an illuminant, and also as a motive power." In view of the experiments with the electric light as adapted to street lighting, which are at present being carried out in the city, considerable interest attached to the lecture, which, it is computed, was listened to by an audience of fully 2,000 persons. The chair was occupied by the mayor (Mr. C. T. K. Roberts), who said the experimental lighting of the city had undoubtedly proved a success; but the question which they as business men had to consider was with reference to the cost. Exeter had excellent advantages for producing the electric light, there being a large amount of water power at the disposal of the city. Mr. Wharton, in the course of the lecture, also said Exeter was in his opinion remarkably favoured for the production of the electric light, because of its natural situation, and the water force which was at present daily running to waste. He suggested the formation of a local company, of which the consumers should be the shareholders. To light the streets of the city by arc lamps would probably cost about £20 per lamp per annum, while the incandescent lamps for domestic purposes would only cost ¼d. per hour. Mr. Massingham, in relating his experiences of electric lighting at Taunton, said that the experiment there had been an unqualified success. The light was to be seen everywhere in the streets, and internally from a church to a billiard-room. Not only had the company paid a dividend of 5 per cent., but they had carried forward a balance representing an additional dividend of 2 per cent. Taking into consideration the water power, he believed electricity could be produced 20 per cent. cheaper at Exeter than at Taunton. Resolutions to the effect—"That in view of the great satisfaction given in the lighting of Exeter streets by electricity, this meeting is of opinion that it would be to the interest of the city, and add to its attractiveness and prosperity, if the public streets were permanently lighted by the system of arc lighting now in use," and that it was the desire of the meeting that a local company should at once be formed for the purpose of supplying Exeter with the Thomson-Houston system of electric lighting for public and private use, were unanimously carried.

The Electric Light and Gas Shares.—The *Standard's* City article on Thursday contained the following information:—"The stocks of the London gas companies were put down from 4 to 7 on renewed alarms about the progress of electric lighting. The Brush Company, however, has not yet secured its street lighting contract from the City Corporation."

The Lighting of the Glasgow Royalty.—Sir Wm. Thomson writes to the *Glasgow Herald*, from which our account of the lighting of the Royalty Theatre last week by electricity was taken, stating that the installation was not carried out under his supervision, but under that of Mr. James T. Bottomley.

Electric Lighting of the Manchester Exhibition.—The cost of "electric lighting" in the official accounts is given as: Amount of contracts, £10,238 12s. 4d.; less received from exhibitors for lights supplied, £714 2s. 6d.; total, £9,524 9s. 10d., the amount mentioned in last week's Notes.

The Telephone in Austria.—The eight telephone systems owned by the Austrian Telephone Company are distributed among the following towns:—Prague, Trieste, Lemberg, Graz, Czernowitz, Pilsen, Reichenberg, and Bielitz-Biala. The progress of the company since its foundation is shown by the following figures:

Year.	Number of subscribers.	Kilometres of wire.
1883 ...	442 ...	1,226
1884 ...	759 ...	...
1885 ...	1,129 ...	...
1886 ...	1,627 ...	...
1887 ...	1,950 ...	4,219

Bradford and the Telephone.—The National Telephone Company opened a new switch room in Bradford on Thursday of last week. The new switch is one of the multiple type, the patent for which belongs to the Western Electric Company of Chicago. As is well known, the wires are so arranged by an ingenious system of duplication that each operator has under her control not only the wires for which she herself is responsible, but also all the other wires connected to the Exchange. The multiple system has hitherto only been adopted in the London, Liverpool, and Glasgow Telephonic Exchanges.

Harrogate and the Telephone.—At the last meeting of the Harrogate Town Council a letter was read from Mr. R. Mewburn, local manager of the National Telephone Company at Leeds, stating that if the Corporation of Harrogate will allow the company to erect wires overhead for the purpose of a contemplated exchange, the company will obtain permission from the various property owners, and at no time make any attachment to the Corporation property, or erect poles in any part of the borough unless the permission of the Corporation is first obtained. The communication was referred to the Highways Committee.

Telephones at Ventnor Hospital.—The Equitable Telephone Association, Limited, has now completed telegraphic communication between the different blocks of the National Hospital for Consumption, Ventnor, Isle of Wight. The hospital is built on the detached principle, being divided into 10 separate blocks united by an underground passage. Eleven A type Swinton telephones—one in each block, and one in the lodge—are employed, the wires being carried through the above-mentioned underground passage straightway to the instruments through the flooring. The instruments are all connected to a central switchboard in the head nurse's room, so that communication between one block and another can be readily effected. Provision has been made in the switchboard for extensions of the system to the houses of the medical officers who reside in Ventnor, should this be considered advisable at some future time. As the hospital is a quarter of a mile in length, it is expected that the telephone will prove a great convenience to the hospital officials.

Mourlon Telephones.—Two new telephone companies, one at Rosario, with a concession for the Argentine Republic and Uruguay, and the other at Cadiz, in Spain, have, after making a comparative examination of all the systems of telephone exchange apparatus, adopted the instruments of Messrs. Mourlon of Brussels.

The Telephone in Devonshire.—At het last meeting of the St. Marychurch Local Board of Health, Torquay, an agreement was signed by the chairman between the board and the Western Counties and South Wales Telephone Company, for the Town Hall being put into communication with the exchange in Abbey Road, at the expense of the company, the latter having, in return, permission to erect poles and posts to convey telephone wires over the St. Marychurch district, subject to the surveyor's approval.

Telephone Manufacture.—The ss. *Gothenburg City* arrived at Antwerp on the 8th inst. from Newport, New Virginia, with 1,270 tons of walnut logs consigned to the Bell Telephone Manufacturing Company. This cargo of walnut, which is one of the largest ever brought to Europe, comprising no less than 1,828 logs, will be used entirely in the manufacture of telephonic apparatus.

Chess-Playing by Telephone.—A match took place at Stirling on Saturday afternoon between teams representing Forfarshire and Perthshire Chess Clubs on the one side and the Glasgow Club on the other. There were 18 players on each side, and the Counties scored 15½ wins to 14½ wins for Glasgow. An interesting feature in the match was the playing of a game by telephone. Mr. Sandeman, one of the players in Dundee, was unable to leave town on Saturday, and he and his opponent, Mr. Forsyth, played a game over the telephone wires.

Dissatisfied Subscribers.—Convened at the instance of Messrs. Marchant, Singer, & Co., a meeting of subscribers to the United Telephone Company was held on Monday, at 84, Bishopsgate Street Within, to take into consideration the proposed change by the company of some of the numbers held by their clients. The change affects for the most part the Leadenhall Street subscribers; consequently, those who were present—some thirty in number—were, almost without exception, representatives of firms in that thoroughfare. Mr. Singer said the company seemed adverse to the withdrawal of their notice of change, so that his firm had put themselves into communication with other subscribers, their opinions being so unanimously opposed to the change that it was ultimately decided to call the meeting to ascertain what measures should be taken to endeavour to get a redress of grievances. He had received several letters anent the change, and all, with one exception, were utterly opposed to it. The subject having been discussed, all the speakers being opposed to the change, it was resolved:—"That this public meeting of telephone subscribers strongly object to the proposed change of numbers on the point of its great inconvenience and expense, besides leading to constant mistakes in orders and inquiries, and hereby appoints a committee to confer with the directors, and report again to the subscribers." A committee was appointed, and the proceedings terminated with a complimentary vote to Mr. Singer.

Threepenny "Telegraphones."—Mr. E. Cox-Walker, who a short time ago wrote in advocacy of threepenny telegrams, regards the recent pronouncement of the Postmaster-General that before long telephones must be "placed on the same footing as telegraphs, and be controlled by the Government," as a large step in the direction indicated by him. He further says:—"This I have foreseen for a long time, and as we are already able in many towns to communicate by telephone with our friends at a distance upon payment of threepence, the acquisition of this system and its incorporation with the general telegraph system of the country must result in the adoption of 'threepenny telegrams,' and an enormous increase in the number of telegraphonic messages."

The Telegraph Factory at Holloway.—In answer to Mr. Norris in the House of Commons last week, Mr. Raikes said:—The number of men employed in the telegraph factory at Holloway is 180, of whom 30 are foreigners. The selection of fresh workmen is made solely according to the qualifications and character of the men applying for work, and in the last two years only two new foreigners have been engaged. The Controller of Stores, under whose supervision the factory is, has, I regret to say, been absent on account of illness for the last 12 months, but has not for the past six months received full pay. I have recently applied to the Treasury to grant him a superannuation allowance.

A correspondent of the *Star* controverts this statement, and says there are only 130 men employed at Holloway, a greater proportion of them than 30 being foreigners, while more than two foreigners have been engaged during the past years.

Telegraphic Communications.—It is understood that the First Lord of the Treasury has written to Mr. Henniker-Heaton, M.P., stating that the question of granting an inquiry into the postal and telegraphic communications between England and all parts of the empire is under the consideration of the Cabinet.

Submarine Telegraphs.—In reply to questions from Sir G. Campbell and Mr. Henniker-Heaton on Monday, Mr. Raikes said: The Submarine Telegraph Company has been informed that it is not the intention of Her Majesty's Government to agree to any renewal of the concession to them which will expire shortly. No agreement has been come to with the company as to the purchase of its plant and transfer of the undertaking; and I do not think it would be to the public interest that any statement as to the details of negotiations should be made until some definite decision shall have been arrived at.

Indian Telegraph Department.—Mr. King asked the Under-Secretary of State for India, on Tuesday, whether he would lay upon the table a copy of the despatch of the Secretary of State with reference to the block in promotion and other grievances of the Telegraph Department in India; whether any officers of the department had as yet accepted the offer for retirement made in that despatch; whether, under the system of grading instituted by that despatch and the abolition of the privilege hitherto in favour of officiating promotions being from grade to grade, many officers were mulcted of a large percentage of their emoluments while the Government saved a very large sum; on what grounds permanent promotions were fixed by the despatch to be made only twice a year, on April 1st and October 1st, and whether he was aware of any precedent for such a provision in any other service of the Crown; whether the fixing of March 31st as the latest date for the submission of retirements had practically operated to take away the inducements for retirement in nearly all the cases, if not in every case, where retirement under the regulations of the despatch would have offered any advantage; and whether, in the circumstances, the Government would reconsider its proposals. Sir J. Gorst: (1) Yes, if the hon. member will move for it, I will lay it on the table. (2) None. (3) No officers are damaged, as the rights of all existing officers are safeguarded. (4) No such provision is made in the despatch. It was introduced by the Government of India, but no reasons for it have been communicated to the Secretary of State. (5) The date, March 31st, was fixed to give every officer ample time for consideration. The Secretary of State is not aware that the inducement to retire has been taken away thereby. (6) The Secretary of State will wait till March 31st before further considering the matter.

Failure of a Contractor. — The Vienna papers announce the failure of M. Biedermann, the contractor for the works connected with the Opera House electric light installation. The liabilities, it is said, amount to about 2,000,000 francs. The firm of Schenek and Farbaky, manufacturers of accumulators, is reported to be one of the largest creditors.

Fire.—The roof of the building at Kensington Court, occupied by the Kensington Court Electric Light Company, became ignited from an unknown cause one morning last week, and six engines were turned out for the call. Some workmen, however, made efforts to extinguish the flames before they had had time to spread, and in the result the roof only was damaged.

A Sad Case.—At about one o'clock on Sunday morning, the 12th inst., a very well-dressed man rang the bell at the gates of the Elysée and ordered the *concierge* to conduct him immediately into the presence of the President of the Republic, having, he said, to make to him a communication which could not be delayed. "I am God," he added, "and God does not wait, go on!" Recognising him, the *concierge* called two officers, and the poor lunatic was conducted to the station in the Rue d'Anjou, where he passed the night. The following morning the chief of police sent him to the infirmary of the Depot, where, a few hours later, he was examined by Dr. Garnier. The unfortunate man, who is afflicted with lunacy and general paralysis, is no other than M. Lucien Gaulard of secondary generator fame.

Theatre Wiring.—Messrs. Henry F. Joel and Company inform us that their wiring of the auditorium circuit of the Empire Theatre, which was originally intended to have its own generating station, has been passed and accepted by the Grosvenor Gallery Company, which is now supplying current for the lamps. We have been allowed to inspect samples of the wire used, and these appear to be perfectly satisfactory from both electrical and mechanical points of view.

Personal.—Mr. Willoughby Smith informs us that his resignation of the position he held with the Telegraph Construction and Maintenance Company was not owing to ill-health. Mr. Smith was last week staying in Eastbourne, in excellent condition, and to keep out of harness is, he says, diametrically opposed to the advice of his physician, Sir Andrew Clarke. We are vary glad to have this opportunity of correcting our former note.

We understand that Mr. Thornton, the manager of the Leamington installation, has gone to America, presumably to look after his "simplex" lamps, for which, we hear, there is a great demand.

The Crompton-Swinburne Dynamo.—We have received a reply to Mr. Swinburne's letter from Mr. Brown, of the Oerlikon Works, but owing to its late arrival, and being somewhat lengthy, we are compelled to leave it over till next week.

Lecture on Electricity.—Mr. Wm. Lynd, M.S.T.E., F.R.M.S., delievered a lecture on electricity at Bourne Hall, Bournemouth, on Tuesday evening last week. He described, in popular language, the manner of working land and submarine telegraph lines, the telephone, and discoveries in electro-physiology and electro-therapeutics. Electro-quackery came in for strong denunciation from the lecturer, who warned his hearers against having aught to do with those largely-advertised "eminent medical electricians" who make a business of trading upon the credulity of the public. The interest was sustained throughout the two hours occupied by the lecture, and the hearty thanks of the audience were accorded to Mr. Lynd. Bourne Hall was fitted up by the E.P.S. Company with a perfect installation of the electric light last Wednesday for a further lecture by Mr. Lynd on electric lighting.

Exhibition at Munich.—The exhibition of motors and their adjuncts at Munich will open early in August. No heavy machinery will be exhibited, the objects in view being to give an impetus to the more general employment of small motors for handicrafts, and to afford an opportunity to German manufacturers of this class of machinery of coming before the public.

Voltmeter for Testing Secondary Batteries.—The Walsall Electrical Company is now introducing a voltmeter graduated up to 3 volts for testing accumulator cells. The instrument appears to be well finished in every respect, and the price is low, and from specimens submitted to our notice we imagine that they will meet with a considerable demand.

The Electro-Harmonic Society.—The next concert of this Society takes place on March 2nd, and the programme, which may be seen on p. 5 of our Supplement, contains names which should be sufficient to draw a "crowded house." It was announced at the last meeting that on this occasion efforts would be made to rely upon members and their friends to provide the evening's entertainment, and this has been carried out in a manner which we hope will be found highly satisfactory. An innovation will also be made in the seating of the audience, it being proposed to have the room arranged as at the smoking concerts. This will provide greater freedom, will be less stiff and formal, and will enable friends to meet and exchange a few words without the necessity of waiting until the interval. We may add that this "Bohemian" style of arranging a concert-room is now generally adopted by several well known musical societies.

Removal.—Messrs. A. B. Gill & Co., whose works were formerly at Lewisham, have removed to larger and more suitable premises at 4, Bombay Street, Bermondsey, where they have every appliance for carrying on an extensive manufacturing business, and ample room for development.

The Telephone in Scotland.—The list of the National Telephone centres at 31st December last shows that the total number of exchanges is 104; call offices, 192; exchange lines, 7,301; private lines, 1,177—together, 8,478 lines. In Scotland the telephone is at work in the following towns:—Edinburgh, Leith, and Granton, Glasgow, Kirkintilloch, Hamilton and Blantyre, Motherwell, Coatbridge and Airdrie, Dumbarton, Helensburgh and Cardross, Kilmarnock, Ayr, Troon, Irvine, Ardrossan, Greenock and Port-Glasgow, Paisley, Johnstone, and Renfrew, Falkirk, Grangemouth, Stirling and Tillicoultry, Alloa, Bridge of Allan, Linlithgow, Kirkcaldy, Dunfermline, Dundee, Forfar, Perth, Arbroath, Galashiels, Selkirk, Hawick, Aberdeen, Inverness. The number of call offices in Glasgow is 42, in Edinburgh 13, and in Dundee 11.

The Powers of Faith. — *Apropos* of our recent references to the use of magnetic and professedly electrical apparatus for curative purposes, comes the story of the lady who, misunderstanding her medical adviser when he assured her that *edax rerum* was the only remedy for her complaint, went to the chemist for the specific she thought the unknown words implied, and, taking with absolute faith the nostrum which was given her, was able recently to announce to her doctor her complete recovery, thanks to his last prescription. An action for the recovery of the money paid for the supposed "*edax rerum*" is pending, and when the trial comes on there will no doubt be plenty of fun; but what we set out to say was that the "cures" effected by the galvanic and other belts are probably very much after the same order as that of the lady who was so nicely duped by the chemist's assistant.

Electric Current at 7¼d. per Unit.—The London Electric Supply Corporation, recently formed with a capital of £1,000,000, announces that its Deptford works will shortly be in operation, and that it is now prepared to make arrangements to supply current for public or private lighting by meter at the rate of 7¼d. per Board of Trade unit, which is equal light for light to gas at 4s. 2d. per 1,000 cubic feet. Further particulars will be found in our advertisement pages.

Fire Alarm Posts at Portsmouth.—At the request of Sir Wm. King, Chairman of the Watch Committee at Portsmouth, the Western Counties and South Wales Telephone Company has erected fire alarm posts, by way of experiment, at Kingston Cross and Palmerston Road in that town, so as to afford direct communication with the central fire brigade station. The *modus operandi* is described as follows: When a fire occurs a policeman, or a passer-by, gives the alarm by breaking the glass and pulling the knob, which drops an indicator in the chief fire station and rings a bell. By a very simple arrangement the bell is kept ringing in the post until the signal is answered at the chief fire station, when it immediately ceases to ring, and the person giving the alarm is thereby assured that his signal has been answered. There are arrangements in connection with the system which apply simply to the police station and to the firemen accompanying the engine. Thereby the latter are enabled to ask for greater strength, or to inform the police that the fire is not serious, and they need not send further help. The whole of the apparatus has been carefully tested, and to ensure, as far as possible, its perfect working, a covered wire has been run from each post direct to the fire station. The company intend to maintain this system by way of experiment for three months, at the expiration of which period it will be for the Corporation to say whether or not they are willing to pay for its continuance.

NEW COMPANIES REGISTERED.

House-to-House Electric Light Supply Company, Limited.—Capital £350,000 in £5 shares, the first 100 of which are founders' shares. Objects: To form centres in the United Kingdom or elsewhere, at which electric power may be generated or accumulated, and from which the same may be distributed for public and private lighting, and motive power and heating, or for electro-plating, electro-decomposition, telephonic or other purposes. Signatories (with 1 share each): Robt. Hammond, 117, Bishopsgate Street, electrical engineer; James Whitehead, Heycot, Crouch End, electrical engineer; F. W. Bentley, 117, Bishopsgate Street; Cecil G. Hadcock, Shooter's Hill; H. St. John Winkworth, 11, Harrington Road, S.W.; W. Capel Slaughter, 18, Austin Friars; Wm. May 18, Austin Friars. Director's qualification: 100 ordinary shares, or £500 stock. The first directors are George Richardson, Professor Robt. Bentley, G. B. Godfrey, A. P. Trotter and Robt. Hammond. Remuneration, £1,500 per annum, and an additional sum equal to one-tenth of the annual profits (except the amount carried to reserve fund) above the first 7 per cent. paid on the ordinary shares, but the whole remuneration may not exceed £3,000 per annum. Registered 20th inst. by W. Capel Slaughter, 18, Austin Friars.

Hills and Thompson, Limited.—Capital, £5,000 in £5 shares. Object: To acquire property at Liverpool or elsewhere, and to carry on business as electric light and power contractors, electrical and mechanical engineers, and as scientific apparatus and appliances manufacturers. Signatories (with 1 share each): *A. J. Hills, 2, Hope Place, Liverpool, electrical engineer; *C. Hart Thomson, Hoylake, electrical engineer; J. E. Banks, 23, Balmoral Road, Liverpool; Rev. W. J. Hiles, M.A., Newbold-on-Stour Rectory; B. H. Abrahall, 54, Lillyville Road, Fulham; C. Herbert Cooke, 21, Vernon Terrace, Brighton; E. H. Fowle, Penkridge, Stafford. The two first subscribers are appointed managing directors, and will be entitled to a salary of £400 per annum, to be divided equally, and in addition one-half the net profits above 5 per cent. per annum, and three-fourths of the net profits above 10 per cent., after providing for losses, depreciation, &c. Registered 21st by Hooper and Son, 69, Ludgate Hill, agents for Brabner and Court, 10, Cook Street, Liverpool.

Notting Hill Electric Lighting Company, Limited.—Capital, £100,000, in £10 shares. Objects: To carry on in all branches the business of an electric lighting company. Signatories (with 1 share each): *S. Waters, 24, Ladbroke Square, W.; *James T. Jarvis, Esq., F.R.G.S., 30, Ladbroke Square, W.; *William Brookes, Esq., 7, Kensington Park Gardens, W.; Joseph Brookes, Esq., 7, Kensington Park Gardens, W.; *Alex. Howden, Esq., 72, Holland Park, W.; *Francis Radford, Esq., 26, Pembridge Gardens; *Aston Webb, Esq., 13, Camdowne Crescent, Notting Hill. Directors' qualification, £150 of share capital; the first are the subscribers denoted by an asterisk; the company in general meeting will determine remuneration. Registered 21st inst. by Loughborough and Gedge, 20, Great Winchester Street.

Ticket Punch and Register Company, Limited.—Capital, £50,000, in £5 shares. Objects: To carry on business as mechanical and electrical engineers, machine and engineering tool makers. Signatories (with 1 share each): G. Wilson, Wednesbury; W. Simkin, Wednesbury; W. Cubett Whitehouse, Darlaston; E. Horton, Darlaston; H. E. Horton, Darlaston; J. Davies, Walsall; Nathan Horton, Wednesbury. The signatories are to appoint the first directors; qualification for subsequent directors, £250 in shares or stock; the company in general meeting will appoint remuneration. Registered 21st inst. by R. Jordan, 120, Chancery Lane. Solicitors: Messrs. Slater and Co., Darlaston.

Macmahon's Electric Automatic Registering Company, Limited.—Capital, £20,000, in £1 shares. Objects: To acquire inventions relating to measuring, checking, recording, and registering the supply of liquids or other articles; and to adopt an agreement of the 15th inst. between F. E. Macmahon and T. R. Clarke. Signatories (with 1 share each): F. E. Macmahon, 2, Prince's Mansions, Victoria Street (electrician); A. H. Young, Stock Exchange; C. A. Verner, 30, Wood Street; H. Jackson, Thrale Road, Streatham Park; T. R. Clarke, 53, Coleman Street; B. S. Filrose Spencer, 97, Shepherd's Bush Road; R. Addison, Burstow, Surrey. The signatories are to appoint first directors. Registered 21st inst. by Ashurst, Morris & Co., 6, Old Jewry.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Mayfield, Cobb and Company, Limited.—An agreement, dated 29th ult., relates to the purchase by this company of the business of Wm. Cobb and Sons, of Market Street, Woolwich, dry plate box, plush frame, and general manufacturers and photographers. The consideration is £3,000, payable £1,125 cash and £1,875 in fully-paid shares. Mr. Wm. Cobb is to be appointed managing-director at a salary of £300 per annum, and binds himself to take no dividends on the fully-paid shares to be allotted to him until the other shareholders receive 5 per cent. per annum.

An agreement of 30th ult. provides for the purchase of the business of electricians and manufacturers carried on by John Thomas Mayfield and Joseph Torr Todman, trading as J. T. Mayfield & Co., at 35 and 41, Queen Victoria Street. The purchase consideration is £5,000, payable £1,875 in cash and £3,125 in fully paid shares. The vendors are to become managing-directors at salaries of £300 per annum each, and have also con-

sented to forego dividends upon the shares of the purchase consideration until 5 per cent. per annum is paid to the general body of the shareholders. After 10 per cent. has been paid on all the shares (including the vendors'), the surplus profits are to be divided equally between the shareholders and vendors.

House-to-House Electric Light Supply Company, Limited.—The signatories to the company registered under this title on 16th ult. have requested the Registrar to remove the company from the register, and on the 18th inst. it was resolved "that the company shall cease to carry on business." Consent has been given to the use of the same title by a new company.

Electrical Automatic Delivery Box Company, Limited.—An agreement of 9th inst., filed on the 18th inst, provides for the purchase by the company from Mr. S. T. Galloway, of 50, Old Broad Street, of the letters patent, No. 13,005, for £30,000, payable £10,000 in cash and £20,000 in fully paid shares.

Whitehall Electric Supply Company, Limited.—The statutory return of this company made up to the 18th inst. was filed on the same day. The nominal capital is £200,000 in £5 shares. 1,482 shares have been allotted, and upon 1,450, £1 per share has been called and paid, and £5 upon the remaining 32 shares.

Armstrong's Electric Light and Power Company, Limited.—An agreement dated November 1st filed on the 16th inst. provides for the purchase of the trade marks, trade secrets, and secret processes of Mr. James Farbottom Armstrong relating to electricity. The purchase consideration is £10,000 payable £500 in cash and the residue in fully paid shares.

Telepherage Company, Limited.—An extraordinary general meeting of the shareholders in this company was held on the 18th inst. at Winchester House, Old Broad Street, when the following resolution was passed :—"That upon this resolution being approved or assented to by the holders of not less than three-fourths of the "A" shares and "B" shares respectively now in issue, it is hereby declared that Article 139 of the company's Articles of Association be and is hereby cancelled, and the following substituted therefor, viz :—Article 139. Upon any winding up of the company as and between the holders respectively of the "A" and "B" shares, the property and assets of the company shall belong as to two-third parts thereof to the holders of the "A" shares, and as to the remaining third part thereof to the holders of the "B" shares.

United Telephone Company of Rosario, Limited.—The registered office of this company is now situate at 78, Coleman Street, E.C.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 17th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £5,612.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th February are £3,910, as compared with £5,012 in the corresponding period of 1887.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

(*Concluded from page* 180.)

Since the supply mains have to carry currents of very high potential, it is advisable that their insulation from one another, and from earth, be as high as possible, and consequently, where feasible, it is better to put them above ground. Such, however, is not always possible, as local authorities in some places, notably in Paris, will not permit this, and the question of proper insulation then becomes a serious matter. Another question also involved, and one which makes an important feature to be considered, is the tendency that alternating currents have to break down the dielectric of their conductors, especially when such conductors are in close proximity to the earth; and retardation of the current under these conditions also comes into the question to an extent not occurring with aerial lines. I know of but one supply station working on this system with high potential transformers in parallel where the supply mains are placed underground, and this is at Tours, in France. M. Naze, the engineer who carried out the work, however, tells me that he has experienced but little difficulty from these sources, although the installation has been at work now for over two years. The mains, both supply and distributing, are laid in earthenware troughs

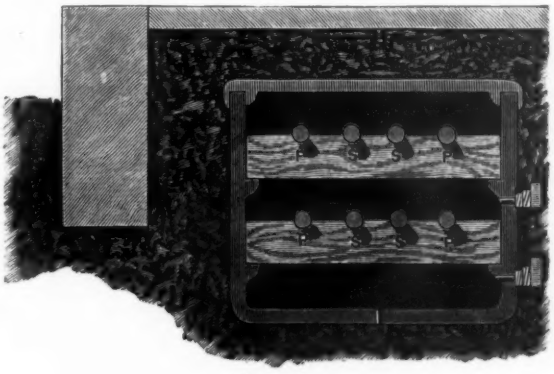


FIG. 17.

under the pavement in the streets. Fig. 17 shows in cross section an arrangement I would propose, which resembles in many respects that adopted at Tours, and which I have reason to believe would be found efficacious. The troughs (rectangular in form) would be about 4 feet long and 15 inches deep, having spigot and socket joints at the ends, after the manner of ordinary socket pipes, so that complete continuity could be maintained. Transverse pieces of wood, resting upon longitudinal projections inside and on the sides of the troughs, would serve to support the mains, both supply and distributing; and a cover, recessed along each edge of its bottom as shown, would make the conduit thus formed fairly water-tight. This cover would also have lapped ends. Any leakage that might occur into the trough would fall to the bottom, and an arrangement for drain-off holes would be provided, so as to keep the conduit clear from accumulated water. The transverse wood joists in themselves offer a fair amount of insulation, and if paraffined would be but little hygroscopic. The mains would be led away, where required, into the houses, through stuffing glands in the sides of the troughs. Repairs and alterations to connections could easily be effected in a conduit of this description. The question involved is, in my opinion, of considerable importance, as sooner or later conductors for lighting purposes will have to go underground in most of our European cities.

Where the supply mains are erected overhead, they may be either supported on poles fixed to the roofs of buildings, as has been done in the supply system from the Grosvenor Gallery, or they may be carried on poles which are placed along the roadways or streets, as is usually the case in the United States.

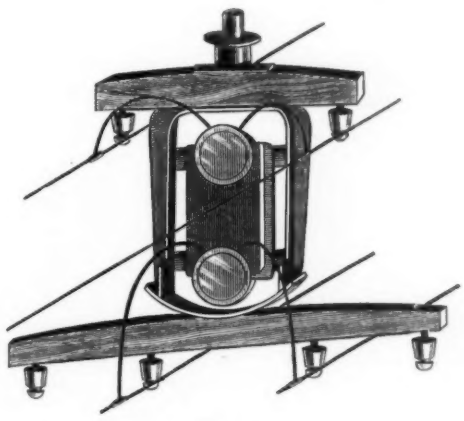


FIG. 18.

Fig. 18 shows the top of the poles that are used by the Westinghouse Electric Light Company, of Pittsburgh, and employed in most of their installations. It will be observed that the transformer itself is supported and carried by the pole in an arrangement devised by Mr. Stanley, of that company, which is very complete and effective.

Generally speaking, where the supply mains are somewhat heavy, it is, in my opinion, advisable to suspend them on bearers, having a factor of safety of at least ten times that of the strain to which they would normally be subjected. The mains would be

suspended from these bearers by insulating rings encircling the main, and attached by wire to the bearer at regular distances of about a yard. The bearers should themselves be of stranded copper wire in cities like this, where free sulphur is so prevalent in the air; and this has lately been done in London, the old steel bearers being replaced by the new copper wire ones. Possibly phosphor-bronze would be very suitable for purposes of this nature, as it possesses great tensile strength. Both bearers and mains should be carried on insulators, which should have the form of double shackles, as this enables branches to be taken off without disturbing the line when up, and also affords greater strength and solidity. When the Grosvenor overhead circuit was first put up for use with series transformers, Mr. Brougham and I employed cast-iron boxes on the poles, into which the ends of the supply mains were brought and sweated into insulated brass

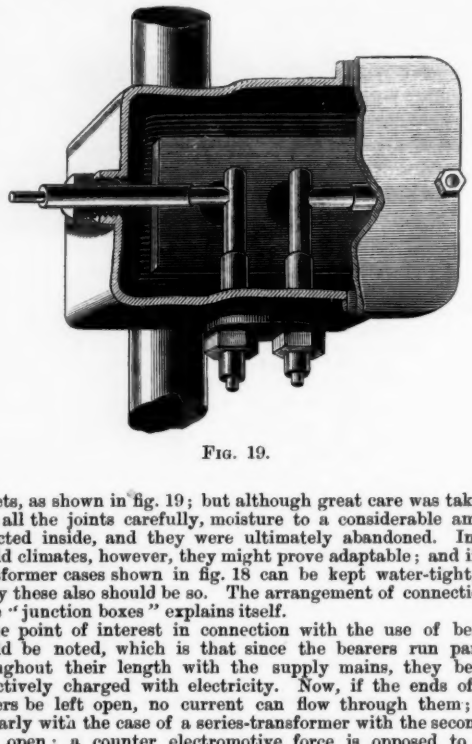


FIG. 19.

sockets, as shown in fig. 19; but although great care was taken to close all the joints carefully, moisture to a considerable amount collected inside, and they were ultimately abandoned. In less humid climates, however, they might prove adaptable; and if the transformer cases shown in fig. 18 can be kept water-tight, certainly these also should be so. The arrangement of connection in these "junction boxes" explains itself.

One point of interest in connection with the use of bearers should be noted, which is that since the bearers run parallel throughout their length with the supply mains, they become inductively charged with electricity. Now, if the ends of the bearers be left open, no current can flow through them; and similarly with the case of a series-transformer with the secondary ends open: a counter electromotive force is opposed to that existent in the adjacent main, which, to a greater or less degree, is retarded thereby. Hence it appears advisable to "close the bearer circuit," if such a term may be employed, and to close it by means of lightning arresters to earth at each end. This is not a "metallic" closing of the circuit, but somehow it appears to produce the desired effect, and also at the same time affords a protection to the line. I am speaking here of lines of several miles in length; of course on shorter circuits the effect is not considerable.

The distance between the two supply mains should be not less than 12 inches; and as, practically speaking, they are at a given moment of opposite polarity, the effect of the current flowing hrough them is, upon telephonic circuits even, almost nil. Possibly some here may remember that when the Grosvenor supply station was started, almost two and a half years ago, havoc was played with the United Telephone Company's wires in that part of London, and to a greater or less degree the effect was felt throughout their whole system. We were then working transformers in series, and consequently had but one wire; and the annoyance grew to such an extent that the company commissioned Dr. Hopkinson to meet Mr. Brougham and myself and study the matter, to find a remedy, if possible, for the trouble they suffered. After several experiments, we found that it was only necessary to run a return wire, and the difficulty would cease, which was at once done. I mention this fact as it may be of interest now that telephone exchanges exist in almost every large town, and the proprietors might raise difficulties in the way of electric light enterprises based on the employment of alternating currents, from the fear that their systems of telephonic communication might be seriously affected and prejudiced.

One peculiar feature connected with electric lighting systems employing alternating currents I wish to bring to your notice, as it may be of interest as well as instructive. It relates to the use of lead-covered cables as conductors. In many ways these cables offer advantages as regards mechanical protection which are not possessed by others, but the mere fact of the existence of this metal covering brings into play difficulties which might not have been supposed likely to occur.

An installation has been erected in Aschersleben, in Germany, by the National Company, owners of the Gaulard-Gibbs patents, which has for a long time worked successfully. When it was first started, however, lead-covered wires were employed as supply and distributing mains; and though great care was exercised in laying them down, it was found that no insulation could be maintained, as they were always breaking down and becoming useless. The reason was due to this interesting fact—that the alternating current flowing through the cable set up and induced current in the lead covering, which at places along its length used to spark across to the supports—at first very slightly, but sooner or later to a considerable extent; the lead covering would then at these places become melted, and so exposing and injuring the dielectric, completely break down the insulation. The lead-covered cables have since been discarded, and ordinary conductors employed. It must be noted, however, that under any circumstances good insulation is difficult to maintain in this installation, for Aschersleben being the site of chemical and salt works, everything becomes more or less impregnated with that substance after a time, and so the chances of a breakdown through imperfect insulation are greatly enhanced.

In designing an extensive electric light installation in a town, one of the main points to be considered is where the transformers are to be placed. Generally speaking, two courses are open—either to place a transformer in each house, or to locate transformers at various places in the town with distributing mains from them along the streets, overhead or underground, to supply the houses as required.

In many cases the first method is preferable, where, as at the Grosvenor Gallery central station, a supply is given to but a comparatively small number of the neighbouring houses, and customers can be, as it were, selected, and where the installation is in the first instance erected as an experiment. Under these and similar conditions, transformers placed in each house to be lighted is, perhaps, the best method of proceeding; but in all installations based on a thoroughly practical design distributing stations must be employed as a means of obtaining a more perfect supply and control over the system. The transformers are thus placed out of the reach of all but the company's servants, and cannot be tampered with, whereby accidents are more easily avoidable. The position of these transformers depends, of course, upon the amount of lighting to be done in their neighbourhood, and I prefer to so locate them that the furthest house supplied is not more than 120 yards from the nearest transformer. This allows but little fall of potential in the distributing mains from each instrument, and, as Professor Forbes showed in his Cantor Lectures before the Society of Arts, is about the most economical distance at which lights can be worked.

The Westinghouse Electric Company, in their installations, couple all their secondaries or distributing mains together throughout the area lighted, thus equalising the potential over the district, and also in the case of a breakdown of one transformer preventing the extinction of the lights which were fed by that particular instrument. This system is practically a "network" system of distributing mains (see fig. 14), and involves a large amount of calculation in proportioning the sizes of the conductors, especially of those which join one group with another, if an installation to be thus carried out be properly and carefully gone into. I believe in practice, however, our American friends do not trouble themselves much with regard to this matter, but continue on with the cables used in the neighbouring districts.

Transformers, when thus placed to supply districts, may be located in cellars, in little street boxes under lock and key, or may be placed on the poles as before described.

I have here a plan of the mains, supply and distributing, worked out for the town of Port of Spain, Trinidad, which installation will be an interesting one, from the extent of the area lighted. I have not adopted the network system in this instance at present, on account of the scattered position of the houses; but later on probably all the secondaries will be coupled up, when the lighting in the town becomes general.

All transformers should be protected by fuses or cut-outs, and one of these should be placed on each wire leading from the supply mains to the instrument. On account of the high potential employed, I prefer to use that kind which consists of a thin wire of a length not less than six inches, having a weight, such as a lump of plaster of Paris, in the middle, in order to break the circuit quickly when the fuse goes. It is astonishing the length of arc that can be maintained by a current of 2,400 volts when the circuit is broken, and therefore I think these fuses should be long and well weighted. The secondaries should also have fuses attached between the poles of the transformers and the distributing mains, though these may be of the ordinary type in use with low potentials.

A switch should be provided to open the circuit leading to the primary poles of the transformer; and all switches which thus control high-potential circuits should be made to snap open very quickly, and be so constructed as to make it impossible that they should remain in any other position than hard on or hard off.

With regard to the wiring of houses and buildings supplied with electricity by means of transformers, the rules in force in ordinary installations are of course applicable throughout; but I would remark that on no account should existing gas fittings be utilised in any building, as the chances of a breakdown are very considerably increased. At the Grosvenor Gallery supply station this was brought forcibly to my notice on more than one occasion, and I may mention one instance which occurred some two years ago which will show you what risk is run when gas fittings are so employed.

In a large shop in New Bond Street some of the gas fittings were utilised by the contractor for the attachment of glow lamps,

and all went well till one evening a short-circuit occurred on one of the gasoliers, and the shop was left in darkness. They at once sent over to the Gallery to know what to do; and shortly after a servant came round from a consumer's house in Bruton Street to say that all the lights were out, and in a few moments other messengers came, informing us of further failures of the light elsewhere on the supply circuit.

We found that the current had gone to earth at the shop in Bond Street, destroying the insulation between the primary and secondary of the transformer, and thus putting the primary current to earth. A weak spot existing in the lamp wires at the other house immediately developed itself in the same manner, again breaking down the insulation and putting the primary current to earth at that place as well. The result was that all those consumers situated between the two breakdowns were left in darkness, as the current traversed the earth, or rather the gas pipes, between the two places where the breakdowns occurred, instead of going through the line. When the two faulty transformers had been switched out of circuit, the current again flowed through the line and the intervening transformers, thus restoring the supply.

I would remark that at that time the transformers were in series, but I can quite conceive a similar state of affairs occurring on a parallel supply system.

There appears no real necessity ever to use gas fittings; but if it be a question of expense, let them be entirely disconnected from the gas pipes, and then of course they may be used as any ordinary electric light fittings.

Every house when supplied from distributing mains should have a main switch to control the supply within the building, and where meters are employed this should be placed between the meter and the main. Preferably these should be "double-pole" switches. Fusible cut-outs ought also to be employed in the house mains, and these should be proportioned to suit the maximum current supplied to the house.

In the States, the Westinghouse Electric Company employ almost invariably glow lamps of 50 volts, as they find that these last longer and are stronger than the ordinary 100-volt lamps.

I have now tried to lay before you and explain the general principles of electrical distribution by means of transformers, without entering into theory or into other scientific and theoretical details which the subject involves, since such matter requires independent discussion. My object has been to give you a general outline of the principles involved, and their practical application, as well as some of the experiences I have gained in the matter since I first took it up with Messrs. Gaulard and Gibbs in 1883.

Before concluding, however, I would like to draw your attention to the results of some experiments made by Mr. Willian Stanley, jun., of the Westinghouse Electric Company, and which were briefly described in the American journal the *Electrical Engineer* of September, 1887. I have had no experience myself of what he describes, and can only refer to him as my authority.

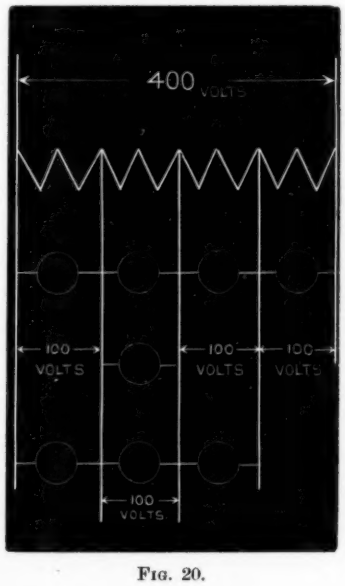


FIG. 20.

Figs. 20 and 21 will show the theory of his apparatus, which, by the way, he calls an "auto-converter," as it consists of but *one* coil only, and no distinct primary and secondary circuits.

Fig. 21 shows one method of raising the potential by means of this "auto-converter." A B is a converter consisting of a single coil, and as it is evident that one half of the coil acts to the other half as the primary of an induction coil to its secondary, the potential between A B is constant, and double that of A C. A current of, say 500 volts could be applied between the points A C of the coil, and if A C were to equal C B, a current having a potential double that of A C could be taken off between A B—in this case 1,000 volts.

Fig. 20 shows theoretically an auto-converter reducing the potential. A B is a coil of one circuit only, and is divided into four equal divisions, viz., A E, E D, D C, and C B. If the potential between A and B be 400 volts, since the subdivisions are equal, they will each have a fourth part of the initial potential, and therefore may be employed individually to supply similar receivers as shown. If the resistance between adjacent divisions be equal, the arrangement becomes a series multiple coupling, and the coil A B has no work to do, consequently losing nothing by conversion. If, however, the resistance between any two adjacent divisions is varied—say, for instance, increased—then that portion of the coil, A B, included between those divisions acts as a primary to the rest of the coil, and the potential difference between all the branches remains constant.

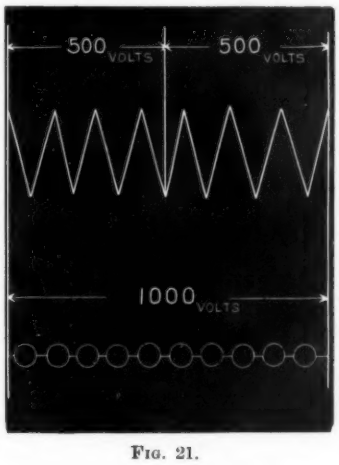


FIG. 21.

From this it appears that the coil acts only to supply an induced current to such resistances in any division as are less than the resistance of the neighbouring branches, and therefore the loss due to conversion is simply that due to the conversion of the current flowing through the algebraic sum of the resistances of the separate branches or divisions. This form of converter possesses the same merit in potential distribution that the three-wire system does in the direct system.

I am not aware whether these auto-converters have been used in practice, and I feel considerable doubt as to what the result might be. One difficulty which appears likely to stand in the way of success with such a system of conversion is that as the high-potential mains are directly connected to the lamp or other receiver circuits, not only are such receivers placed at an equal potential above the earth with the main, but any failure or breakdown in the insulation of the receiver circuits would result in a tendency to destroy the whole insulation of the system, not only at the particular instrument directly connected to the fault, but along the whole line. When breakdowns occur in the insulation between the secondary of an ordinary two-circuit transformer and the earth, there is, at any rate, the insulation between the secondary and primary existing as a safeguard against putting the primary also to earth.

FIG. 22.

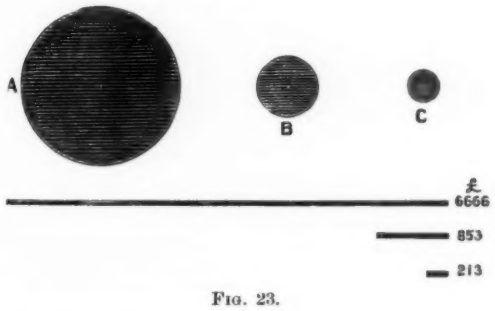


FIG. 23.

I will now conclude by referring you to figs. 22 and 23, which will graphically show you what the development of electrical distribution by transformers or secondary generators has done towards lessening the cost of a general electric supply; although, instead of "lessening the cost," we should, I think, say "rendering electric supply *possible*." The figures are taken from Dr. F. P. Pope's article to the American journal before mentioned. In fig. 22, A, B, and C are drawn double the natural size, but show proportionally the area of cross section of the total mass of copper necessary to supply 5,000 16-C.P. glow lamps, situated at a mean distance of 4,000 feet from the dynamo. A refers to the

three-wire system, working at a potential of 200 volts, with a fall of potential or loss of energy in the feeders of 10 per cent.—the usual conditions under which this system is worked. B shows the size of conductor required for the same work in an installation based on the transformer system, allowing 2·5 per cent. loss in the supply mains—only one-fourth as much as in the direct system. If this loss were increased and made equal to that in the direct system, viz., 10 per cent., the size of conductor would be that shown at C.

Fig. 23 shows what the relative cost would be between each of the three conditions just named. This speaks for itself.

I believe you will agree with me that the introduction of transformers as applied to electric distribution is the greatest step forward that has been made since the great Electrical Exhibition in Paris of 1881.

I append a list of towns in which, as far as I can ascertain up to the present moment, alternating current and transformer supply stations exist, giving the approximate number of lights supplied; but it must of necessity be incomplete, through causes which those who have also tried to collect statistics can appreciate.

CENTRAL ELECTRIC LIGHT STATIONS ON THE TRANSFORMER SYSTEM.

Approximate Equivalent Output in 16-C.P. Lamps.

England.—London (Grosvenor Gallery), about 8,700, Ferranti; Brighton, Lowrie-Hall; Eastbourne, Lowrie-Hall.

Scotland.—Cathcart, about 500, Rankin-Kennedy; Glasgow, 600, Rankin-Kennedy.

France.—Tours, about 2,000, Gaulard-Gibbs.

Germany.—Aschersleben, about 1,000, Gaulard-Gibbs.

Italy.—Tivoli, about 450, Gaulard-Gibbs.

United States (Westinghouse).—Austin, Texas, 1,300; Beaver Dam, Wis., 1,300; Galveston, Tex., 1,300; Denver, Col., 7,000; Steubenville, Ohio, 1,000; Ouray, Col., 300; Tyrone, Pa., 1,300; Charlestown W., Va., 650; Morristown, N.J., 650; Parkersburg W., Va., 2,000; Trenton, N.J., 5,200; New Orleans, La., 5,200; Tampa, Fla., 600; Springfield, Mass., 2,000; Pittsburgh, Pa., 12,000; Pittsburgh, Pa. (East End), 2,000; Buffalo, N.Y., 2,000; Greensburg, Pa., 1,300; Torrington, Ct., 1,300; Littleton, N.H., 650; Phila, Pa., 2,600; Stapleton, Staten Island, 2,000; Savannah, Ga., 1,300; Portland, Me., 650; Easton, Md., 650; Colorado Springs, Col., 1,300; Hartford, Ct., 2,000; St. Louis, Mo., 5,200; Minneapolis, Min., 6,500; Richmond, Va., 1,300; Pittsfield, Mass., 1,300; Sheffield, Ala., 650; Cornwall, Ont., Canada, 650; Wheeling, W. Va., 2,000; Chattanooga, Tenn., 1,650; Pittsburgh, Pa. (S.S.); Allegheny, Pa.; Philadelphia, Pa., 2,000; Plainfield, N.J., 1,300; Schenectady, N.Y., 1,300; Philadelphia, Pa. (S. and C.), 1,300; Carbondale, Pa., 1,950; Lincoln, Neb., 2,000; Flint, Mich., 650; New London, Ct., 2,600; Duluth, Minn., 1,300; Bemington, Vt., 650; St. Cloud, Minn., 650; Fort Scott, Kans., 650; Hillsdale, Mich., 400; San Antonio, Tex., 650; Springfield, O., 2,000; Cheboygan, Mich., 650; York, Pa., 650; Oneonta, N.Y., 650; Nashville, Tenn., 1,300; Peekskill, N.Y., 650; Cedar Rapids, I.A., 1,300; Bath, Me., 650; Port Huron, Mich., 650; Stillwater, Minn., 650; Marion, Kans., 650; Junction City, Kans., 650; Buffalo, Wyo. Terr., 400; Newton, Kans., 650; Hoboken, N.J., 1,300; Altoona, Pa., 650; Havoac Tunnel, 1,300.

An extraordinary meeting of the society was held at the Institution of Civil Engineers, 27, Great George Street, Westminster, on Thursday, 16th February, 1888, Mr. W. H. PREECE, F.R.S., (Past President), in the Chair.

The minutes of the last meeting having been read and confirmed,

Mr. KAPP, on the invitation of the Chairman, having pointed out one or two errors in the proof of his paper, Prof. Ayrton was called upon to open the discussion on the papers read by Mr. Kapp and Mr. Mackenzie.

Prof. AYRTON: I think we ought first to congratulate the authors of these two papers on having given us two most interesting communications on a subject of all importance at the present time. I agree with Mr. Mackenzie that a good deal of credit is due to Messrs. Gaulard and Gibbs, not for having invented (even if they have invented) a new method of distributing electric energy, but for having drawn attention, in an experimental way, to this matter. At the exhibition close by (in the Aquarium) in August, 1882, the system was worked, but it certainly did not commend itself to many who saw it when it was first shown. I think many of us who saw the secondary generators, or, rather, a secondary generator, at the Aquarium, had no idea that in a few years the system would be employed on the largest distribution of electric energy in this country. One reason, I think, perhaps, why some of us, at any rate, did not appreciate it was that the measurements shown us were made extremely inaccurately, and we feared that possibly the system would be as unsatisfactory as the methods employed to measure its efficiency. Of course, this in no way detracts from the advantages of the transformers. I merely wish to refer to the impressions formed in regard to the transformers when at work in 1882. For example, the potential difference at the terminals of the transformer was then measured by means mainly of a high-resistance dynamometer, and that was multiplied by the current as measured by a low-resistance dynamometer, and the conclusion was at once come to that that measured the watts. Well, that was supposed to measure the watts put in, and gave us a result which might, or might not, have any connection with the true efficiency, and therefore one felt more inclined to be guided by the fact that the core of the transformers was extremely hot in concluding that the system was not practically good then, rather than by the results of experiments which were obviously incorrect. In attempting to measure the power given by this alternating current system by the product of the reading of even a proper voltmeter, such as a Cardew voltmeter and a low-resistance dynamometer, I may mention that it is exactly as if an endeavour were made to measure the power given out by an engine by measuring the pressure as read by the pressure guage and the speed as measured by the number of revolutions, without taking any account as to whether there is an expansion or what is the adjustment of valves. Every mechanical engineer knows that if the pressure were so much in the cylinder and the engine were going at so many revolutions a minute, therefore the engine was doing a certain number of horse-power work would be a most unscientific conclusion to deduce. Now, the volt measurements were not then made by the Cardew voltmeter, because it did not exist (as far, at least, as I can remember), but by an instrument named a high-resistance dynamometer, which added another error, so that there was a collection of errors in the measurements. Nevertheless, the system is, in spite of this, an extremely good one, as shown by the fact that it is used very extensively in London and elsewhere in Great Britain, and very largely used, as shown at the end of Mr. Mackenzie's paper, in the United States. The next point that, perhaps, would suggest itself in this discussion is the question of safety to life. Of course, you are dealing with a very high-potential difference in the primary. How can we take care in this system to avoid danger when the primary touches the secondary? A very ingenious device was described by Mr. Kapp last time, and he also showed an equally ingenious arrangement—Captain Cardew's—a combination of electrometer and fuse. But it appears to me that there is a far simpler device, merely consisting of putting one wire of every secondary to earth. What we want, of course, is to ensure not merely that the difference of potentials between the primary and the secondary shall not exceed a certain value, but that the mean potential shall not differ from the potential of the earth by more than a certain value. It is not sufficient to know that the difference of potential between these two mains in the house is never more than a hundred volts, we must know that the potential of neither differs much from the potential of the earth. Well, that condition, it seems to me, is at once found by putting one of the terminals of every secondary to earth. If there is a proper insulation it does not affect the insulation of the primary circuit in the least, and it ensures perfect safety in the secondary arrangement. It also has this advantage (pointed out some time ago), that it prevents a discharge due to the electrostatic capacity of a transformer, which may be considerable. You may get a shock either from the want of insulation between the primary or the secondary, or by the secondary and primary forming a Leyden jar. Now, this device of putting one terminal to earth is one that gets over that difficulty, and you get perfect safety with an arrangement which cannot possibly fail. I have spoken of the "differences of potentials" at the terminals of the secondary. I think that is better than Mr. Kapp's expression of "electromotive force." "Electromotive force" should not be employed when you are speaking of the potential difference between two points, because you are liable to confuse it with the electromotive force of the whole circuit. "Electromotive force" ought to be retained as an expression for the electromotive force of the whole circuit. It means the potential difference between the terminals of the primary. It avoids confusion in calculation, especially when they are complex.

(To be continued.)

American Institute of Electrical Engineers.

THE paper upon this subject, which we published in the REVIEW for January 13th, was read at a meeting of the American Institute of Electrical Engineers on December 6th, 1887, when it was discussed as follows:—

Mr. TOWNSEND WOLCOTT: I would like to ask Mr. Stanley if he has ever observed an effect in reversing the magnetism of the cores other than that of the Foucault currents, that is, a sort of magnetic friction; the mere reversal of polarity, independent of any induced current, producing an amount of energy. I do not know how much it is. I know that some years ago a French physicist experimented with alternating currents, using a copper core in one case and an iron core in another. Had the heating effect been due to the Foucault current, the copper would have become much hotter than the iron, while in fact they did not get hot at all, while the iron became hot; so there was an effect due to the simple change of polarity—a sort of friction—it is analogous to friction. I would like to know how much effect that has in practice on the alternating systems.

Mr. STANLEY: In measuring the loss in an induction coil we have found a very slight unaccountable waste, so slight, though, as to be almost immeasurable. It depends somewhat on the number of alternations that are driven through the coil. With about 16,000 alternations a minute the temperature of the coil, if it were placed in a calorimeter, would be indicated. The temperature of the calorimeter would indicate very nearly the amount of energy which was due to $c^2 R$, or the heating of the conductor itself. The iron of the core of the converter or the induction coil remains at a very low temperature indeed. Of course there is a considerable radiation while in the air. Mr. Shallenberger, in Pittsburgh, has made several careful measurements, and we are enabled to find that there is hardly any perceptible loss from

magnetic friction. I can well say that with a very high degree of magnetisation where the core was of a limited area in proportion to the number of ampère turns surrounding it, that there might be a considerable waste due to magnetic friction or magnetic saturation, and with the induction coils as made for the distribution of electricity for lighting purposes this is very small indeed. I cannot tell you its extent, but it is very small.

Mr. HOWSON called attention to the fact that a distinction had to be made between the true alternating current and the reversed or interrupted direct current.

Mr STANLEY remarked that for the purpose of distribution by means of transformers the interrupted or reversed direct current was of very little value, and said further: With your permission, I will endeavour to sift out this subject a little bit more. As I understand it, the effect of joining the magnetic circuit around the primary and secondary induction coil is practically to reduce the wire, if I remember correctly, to about one-sixth. In experimenting with coils, to begin with, I took Faraday's ring and wound a coil on either side. The best coil I have ever seen consisted of a bundle of perfectly straight wires on which was threaded a lot of iron washers. This has the highest counter induction per unit of length of any coil I have ever seen. In the Westinghouse company's system we get about two volts per foot of wire. This coil gave, if I remember correctly, about a volt to four inches. But it was impracticable to construct, as you could not make them fast enough. As I understand it, the curves of electromotive force induced from an alternating current are these. A, B, C, D, E (see fig. 5, p. 7), is a complete period of the curve of the primary or applied electromotive force. Now the induced electromotive force will be maximum at the time when the inductive effect of this primary current is a maximum; and the inductive effect of the primary current is a maximum when it changes from zero to any larger value. Consequently, the electromotive force of the induced current shown in the lower curve, fig. 5, will be a maximum at this time; and it will be a minimum when the inductive effect of the primary is a maximum, and that will be when the rate of change of the primary is the least, viz., at the crest of the primary wave, B and D, we find that the same values of applied and counter electromotive force are just one-fourth of the whole period of phase of the current. That is with an alternating current. In the direct current we never can have as great an electromotive force induced in the secondary circuit because our primary circuit never passes the zero line. The curve of induced electromotive force in the case of a broken, direct or interrupted direct current

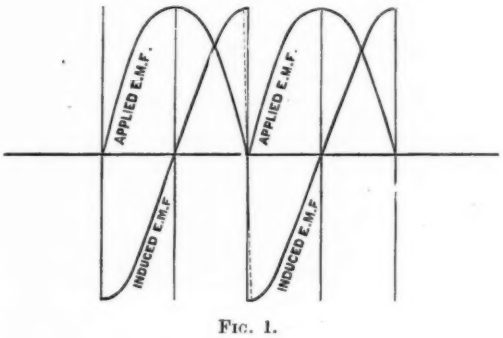


FIG. 1.

I think is this (fig. 1). As will be seen, the induced current will be of negative sign, while the positive current is going to maximum; and the induced current will be of positive sign, while the applied current is falling from the maximum. Perhaps it might be interesting to illustrate the applications of induction coils for covering long-distance distribution. It is well known that the cost of a conductor varies inversely as the square of the electromotive force. The cost of the conductor for transmitting a given amount of energy will be, for 100 volts E.M.F., we will say, x dollars, while for a 200 volts pressure the cost will be $\frac{x}{4}$ dollars. Therefore, the economy of the alternating system over others is directly as the square of the ratios of their electromotive forces. But in order to cover enormous distances and to make the system as broad as possible, I devised another plan which may or may not be new. We are to apply it in Berkshire county, Mass., to distribute from a station over six miles of territory with a loss of 2 per cent. We have 100 H.P. to distribute, and the potential of distribution is to be 4,000 volts. Our alternating current dynamo is of 1,000 volts. In order to get the electromotive force up to 4,000 volts we simply wind one coil of wire and attach our dynamo to intermediate terminals of that wire, distant apart one-fourth of the entire length (as shown in fig. 2). That is, the length included between the terminals is one-fourth of the whole length of wires wound on the coil. There is no secondary circuit whatever. Of course, there is an induced electromotive force upon every turn of wire on that core of so many volts per turn. We apply our electromotive force of 1,000 volts at those points in order to get 4,000 volts between the outside terminals. When we carry our current at this enormous potential over to the place where we wish to distribute we simply attach another self-induction coil similar to the first. On one-fourth of its entire length we tap out another circuit. That reduces the potential from 4,000 volts to 1,000 volts again. The maximum efficiency of an auto-converter, or converter of one coil evidently is found in the case

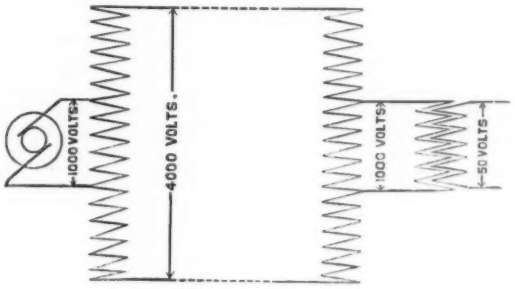


FIG. 2.

where the ratio of reduction is from one to two, or two to one. If you have it in the ratio of one to four, or one to six, the saving is not nearly as great.

Mr. PRESCOTT: I visited the station in the Berkshire hills a few days ago that Mr. Stanley speaks about, and I noticed that they had for the generators one omnibus wire running around the station such as are used in the Edison station. But this omnibus wire was split in two, and each generator worked into its own circuit. I asked the attendant why the omnibus wire was not connected across, and he said that if they connected it across they were likely to burn out their armatures. I would like to ask Mr. Stanley if that is so?

Mr. STANLEY: That is so, through an oversight in the construction of the dynamos in the early stage of the business. We all have to learn some things; and the reason why it has been difficult to multiple-arc alternating dynamos is, that the phases have not been exactly the same. We make our dynamo pole-pieces of cast iron. Those cast iron pole-pieces did not measure to a thousandth of an inch the same width, and consequently the two phases of current, which ought to have coincided, did not coincide exactly, simply because of faulty construction. By tooling off and cutting the width of the pole-pieces to an exact measurement, there is not the slightest difficulty in multiple-arcing two, three, or four alternating dynamos. I think a new feature in alternating currents, perhaps not well known to every one here, is the remarkable self-regulation of the alternating current machine. I cannot speak of it fully, because I have had very little to do with it. Another man is responsible for the beautiful work he has succeeded in getting. In Pittsburgh, a few days ago, I saw a 2,500-light dynamo run by a 250 H.P. engine, and 2,150 lights thrown by a single switch. The rise in electromotive force was 1 volt. I submit that in the present state of the art, it is impossible to construct a direct current machine which shall have anything like the self-regulation these alternating machines exhibit. The resistance at the commutator of a direct current machine would cause a greater variation of potential than was manifested in this machine I speak of. In the induction system we start out with an alternating current machine, in which we pretend to have at least a maximum loss of two volts in electromotive force in the dynamo with the proper regulation necessary to any machine. Towns are wired, at least I know of two pole lines which are wired, for one per cent. loss of electromotive force, distributing electricity generally over an area of about a mile radius. The actual loss in the mains is one per cent. In the induction coil, at full load, there is another loss of two per cent.

Mr. MAILLOUX: I was expecting that somebody would refer to one of the features mentioned by Mr. Stanley this evening, which is to me one of the most interesting, from the theoretical as well as from the practical standpoint, inasmuch as it leads to a scope of applications. It is that system in which four lamps, A, B, C, D, were connected across the terminals of a constant potential alternating circuit; and in which the difference of potential for a particular lamp cut out was taken up by the self-induction coil. Now I would like to ask Mr. Stanley whether the object of using that induction coil was merely to balance the other lamps, or whether it was expected that any energy would be saved by its use; in other words, whether the two lamps running with the circuit continued through the self-induction coil would require less current than would the four lamps.

Mr. STANLEY: The connection of the lamps in series in that way was for a street-lighting system. In order to distribute lamps economically for street-lighting purposes the plan adopted by Mr. Shallenberger was brought out. The shunted coil on the extinguishment of any one lamp prevents the rest of the lamps going out. For instance, there would be 20 lamps attached to a 1,000-volt circuit, each lamp of 50 volts. Now all those 20 lamps may go out, or 19 go out and the remaining lamp would be at approximate candle-power; and yet the sum of the electromotive forces, measured by a voltmeter around the lamps and coils, is far in excess of the electromotive force that is applied to the outside terminals of the series. For instance, there are four lamps connected in series. There was a lamp connected at a. That lamp is extinguished and in place of it there is a self-induc-

tion coil, *e*. This series is connected to a circuit whose voltage is 200 volts; a voltmeter connected to each one of these lamps will show for the lamps, *b*, *c*, *d*, 50 volts each, and for the self-induction coil 100 volts. Now the sum of the interior electromotive forces here is 250 volts. The same voltmeter will show an electromotive force of 200 volts on the outside terminals. That is, the sum of the interior electromotive forces is greater than the applied electromotive force. I think that can only be explained by the retardation of the current producing the average electromotive force.

Mr. PRESCOTT: In regard to the point that Mr. Stanley kindly replied to a moment ago, I would say that it is, of course, well understood that if the time phases of any number of alternating current machines are identical there is nothing to prevent their being worked in a multiple arc. Now the question, to my mind, was whether there is any practical difficulty in getting those time phases the same. Of course that includes not simply the electrical and mechanical construction of the machine; it requires them to be identical in that respect. Now I have seen only two Westinghouse stations, and in both of them each dynamo had a separate engine, and in both cases the machines supplied separate circuits. Is there any case of any plant now in operation where a number of machines are successfully used in multiple arc?

Mr. STANLEY: I think at Denver, Col., a station of 5,000 lights is run with dynamos in multiple arc, although I am not sure. The Pittsburgh station has been run in multiple arc. Our policy is not to run in multiple arc. We prefer not to. There is no choice in the matter excepting only that of simple expediency. We construct the station switchboard so as to connect any circuit leading from the station to any dynamo without causing a flicker in the lights, and thus give the dynamo a definite load that you can read on the ampèremeters. That seems to us to be a very satisfactory way to run. As the evening grows later lights are cut off, the circuits are transferred from a number of dynamos to perhaps a smaller number, and eventually down to one dynamo, which runs all night. The subject of multiple-arcing of the dynamos comes so near the question of running alternate current motors that it is the same question practically, and I feel, perhaps, justified in explaining a little phenomenon in that. If you take two alternating current dynamos and couple them together, and start them up, one dynamo will fall into synchronism with the other. In order to have an alternating current motor, it is necessary to have a direct current through the field and an alternating current through the armature. In order to get a direct current through the field, you have got to have a commutator, which will produce the field current. This current in the field will rise from zero to a maximum value, and fall again to zero value; but the armature currents will be above and below the zero value (as shown in fig. 3). Now notice, that at the time marked by the full vertical lines, there is no current flowing through the field, and there is no current flowing through the armature. If, then, we have an alternating current motor which is running with the exact speed and in conformity with the number of alternations of the dynamo which is applied to it, and have the phases of the two currents in exact synchronism, that is, with equal phases coming together at the same times, we will have absolutely no current in the field while there is no current in the armature of the motor. Now the commutation of the field may be outlined as shown where c, c, c indicate the commutator segments. There has been, until the motor arrived at synchronism, commutation at different points in the phases as at the dotted vertical lines. But when the motor runs at exactly the same speed as the alternating dynamo, there is no force then at work keeping the motor going. In other words, you can run an alternating current motor up to speed, but the minute it goes into absolute synchronism it will fall off again, and the consequence is that the alternating current motor will see-saw. There will be no power to continue its motion. Its speed will fall, and it will drop down to a lower number of alternations, but will rise up again.

Mr. PRESCOTT: What is the effect if you have just enough work on to keep the speed down?

Mr. STANLEY: Then it will never rise to synchronism.

Mr. E. W. RICE, jun.: I would like to ask Mr. Stanley in reference to his last statement as to the motor, what percentage is the variation in speed?

Mr. STANLEY: Of course an alternating current motor in synchronism and kept there, runs at exactly the same speed as the alternating current dynamo does. If the motor is impelled to synchronism and beyond it, it will go to perhaps double the synchronism. If the alternating current machine is run 16,000 alternations per minute, the alternating motor if it goes beyond that number, would never stop until it gets to 32,000 alternations. But the chief difficulty is that it does not develop any counter electromotive force under the conditions described, because it cannot develop a counter potential unless it has at all times a constant field charge. As the current falls to zero, of course, it cannot develop any counter electromotive force at that time. An alternating current motor has no efficiency of any consequence until it arrives at synchronism and becomes practically a dynamo running in opposition to the dynamo applied to it, at which time it has an enormously high efficiency with the most perfect self-regulation.

Mr. RICE: I hardly understand what Mr. Stanley means, in view of some experiments we tried recently. We had a self-exciting dynamo, and ran it in multiple arc with another self-exciting dynamo, and then threw the belt off. The current from the generator proper passed from the armature of the motor. We did not find any variation to speak of, and it ran perfectly in synchronism. It was a generator capable of giving out about 25,000 watts. I then loaded it until the motor was giving out in the neighbourhood of 50,000 or 60,000 watts without any change whatever in speed or any tendency to variation.

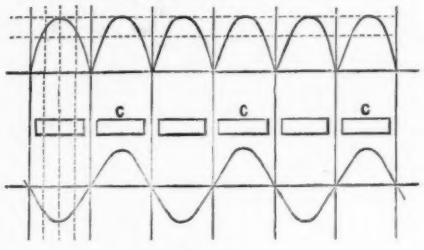


FIG. 3.

Mr. STANLEY: It has an alternating field in which the magnetisation periodically fell to zero. But in the dynamo the gentleman speaks of I understand the magnetisation of the field was always the same. Consequently it was a true alternating current motor.

Mr. RICE: I do not see exactly how that meets the question, because the field of the motor was charged by itself, therefore it was falling from zero to zero again.

Mr. STANLEY: The field of the motor was charged by a current developed by the motor itself on its own armature.

Mr. RICE: Yes sir.

Mr. STANLEY: And the phase of the current did not coincide with the phase of the applied electromotive force.

Mr. RICE: If I understand you for a certain period of time a motor running is exciting its own field. There was no opposition to the primary current from the generator.

Mr. STANLEY: That is true. When the current in the field is zero, and the field charge is zero, then there is no electromotive force producible of course. But if the field charge is constant, then it will develop a counter electromotive force, and become a true motor.

Mr. RICE: I understand you to say that the field would fall to zero from the self-exciting motor.

The PRESIDENT: I would like to ask Mr. Rice if he is at liberty to give us a little information on the point of synchronism?

Mr. RICE: All that I can say in regard to that is that we have tried multiple-arcing dynamos. We have run dynamos together for a period of twenty hours continuously, and the loads seemed to be very equally divided when the speed was kept uniform. We have also experimented with motors, and found no difficulty in that direction. I was very much interested in the system which Mr. Stanley attributes to Mr. Shallenberger. I think it is only just to Professor Elihu Thomson to say that that system was patented by him three or four years ago. He used almost identically that same arrangement, which consisted of placing a self-inductive coil in place of a lamp, so adjusted that it would take just the current of the lamp. I do not know that that was the first time it was done, but so far as I know it was. In reference to the diagram, I understand Mr. Stanley to say it applied to a coil in which there were no iron cores. Is that true?

Mr. STANLEY: Yes sir.

Mr. RICE: And you say that the self-induction follows exactly the primary. Now it seems to me that coils with iron or without iron are the same, excepting a difference in degree; there is no difference in kind. In that case it seems to me there would be a slight shifting.

Mr. STANLEY: The difference in ratio is only one thirty-thousandth, and it being so small, I thought it was not worth while expressing it.

Mr. WHEELER: I would like to ask Mr. Stanley whether there are any losses on the line wire other than that due to resistance—whether there is any current dissipated by retardation, self-induction, or anything of that sort?

Mr. STANLEY: I was perhaps the worst frightened of any man who ever stood on solid ground when I read Prof. Hughes's lecture on self-induction. But the effect of self induction which he described, and the measurements on which it was based, were made with a broken direct current. With the system that we use we have been able to to find hardly any variation from the true Ohm's law, and all our wiring details are based on the assumption that the resistance is the ohmic resistance of the copper only. In the case where the wire goes around an iron core it is not necessary that there should be a loss of electromotive force. The electromotive force is merely retarded for a moment, and as soon as it has fallen to a value below that of the charged magnetism, the stored electromotive force is all returned to the circuit. I think there is nothing so generally misunderstood as the loss of electromotive force in iron cores.

Mr. WHEELER: It is a case of magnetic storage.

Mr. MAILLOUX: I do not think Mr. Stanley exactly answered my question, and the remarks made bring us back to it again. The question is whether in that circuit that he speaks of in which an induction coil is substituted for a lamp, whether the loss of energy, in other words, the expenditure of energy, across that line is different in the second case from what it would be before that induction coil had been substituted. If, as Mr. Stanley argues, the effect of

self-induction is simply to retard the electromotive force, then evidently we still have electromotive force there, and if it does not absorb electromotive force or cause no loss, then we should take less energy than would be accounted for by that which would be absorbed in the three lamps, plus that absorbed in the ohmic resistance, as he calls it, of the self-induction coil. For we must remember that the amount of energy required at the terminals of the induction coil is not as much as would be represented by $c^2 R$. It is $c R$, plus a certain quantity which represents the work done in the induction coil in overcoming the counter electromotive force of the coil. Now, then, it is interesting for us to know whether in that case the expenditure of energy was the same, whether the induction coil was on or whether the four lamps were burning at one time. I incline to the opinion that it must have been the same, and that consequently there must have been a certain amount of work which was absorbed and dissipated by the self-induction coil.

Mr. STANLEY: The energy on the lamp is exactly the same. If it were not the lamps would grow brighter. The potential on them is constant. The current going through them remains constant or they would not be of the same brilliancy. The self-induction coil does waste some energy, but it has the effect of storing energy for a brief interval of time and then returning it upon the circuit. As to the invention of the self-induction coil for this purpose, I have the very highest regard for Prof. Thomson and always had, but if I remember correctly, the patent that Mr. Rice refers to is not for this purpose. It is for cutting in a coil. This is a very different invention. This is a coil always in circuit to do this work, while the coil Prof. Thomson devised is cut into the circuit.

Mr. MAILLOUX: I would like to state then that my conviction appears to be upheld by Mr. Stanley, that, the energy being the same, this induction coil represents nothing more than resistance. It takes up a certain amount of energy which a certain idle resistance would clearly absorb. If we were to replace that self-induction coil by another one having no self-induction, but a larger resistance, so that the circuit going into that resistance would absorb the same number of watts, then we should evidently have the same energy absorbed as we have by that induction coil. So that I do not see the induction coil in question does anything more than to replace a lamp that is put into that circuit. The case is exactly analogous to that of an electric motor that would be placed in circuit. The amount of energy absorbed by an electric motor is the difference of potential at its terminals.

Mr. WETZLER: It occurs to me that perhaps this phenomenon might be due to an error, or a peculiarity, of the measuring instrument employed. Mr. Stanley said that he employed a Cardew voltmeter. I would like to know whether he ever applied the electro-dynamometer for that purpose.

Mr STANLEY: The electro-dynamometer is a very unfortunate instrument to use with an alternating current, as its reading is changed by a slight fluctuation in the alternations. The Cardew voltmeter, which is dependent on the amount of heat produced, is entirely independent of the alternations. Perhaps I can explain that. The coil is acting exactly as a dynamo would act in series and it chokes down the current in direct proportion as the resistance in this part of the circuit is raised. The average electromotive force at the terminals of the coil, however, is greater than would seem to be warranted by Ohm's law.

Mr. HOWELL: Mr. Stanley said that inasmuch as the current was constant (as shown by the lamps) that is, the current in three lamps was the same as the current in four and that the electromotive force acting on the circuit was also constant, that the energy was constant in the circuit. I would infer then that $c E$ is the measure of energy in the alternating current. Is that a correct conclusion?

Mr. STANLEY: No, sir; that was a slip of the tongue perhaps on my part; but it is a most unreliable quantity. The energy of three is the same as the energy on the three lamps before. I think in reality there is very little waste of energy. But there is an apparent amount of energy wasted there—that is $c E$ of coil. This is apparently as much as the energy expended on the lamp.

Mr. HOWELL: I think that that diagram is a very good illustration of the fact that $c E$ is not a measure of the energy in alternating circuit, because you have only a value for c there, and the value of the energy in that circuit would be $c \times 200$. Now that is the sum of the energies in three lamps and the coil, and in each lamp it would be $c \times 50$, and in the other it would be $c \times 100$; so that the sum of these energies is not the same as the sum of the whole circuit computed the other way, which shows $c E$ is not the measure of the energy in the circuit. I would like Mr. Stanley to demonstrate why the current in the secondary increases, or why an increase of current in the secondary increases the current in the primary.

Mr. STANLEY: I think that this is very easy to understand from the diagram of the counter-electromotive force, providing no current is flowing through the coil. The secondary electromotive force will of itself induce another electromotive force, and so we might go on inducing for ever electromotive force. We cannot merely transform energy once: we can transform it a thousand times. Now the secondary electromotive force will develop a counter-electromotive force on the primary circuit, and that will be still one-quarter of a period later. Notice that I have drawn these curves directly opposite. It exactly opposes the primary electromotive force at the same instant of time. Now, when the current is abstracted from the coil, this is no longer the position of the secondary electromotive force; it is shifted on. Consequently, the counter-electromotive force no longer opposes the primary electromotive force at the maximum time of the primary electromotive force, and consequently its value as a counter or opposing E.M.F. is very much lessened. You have asked me a difficult question.

Mr. WHEELER: I would like to return to the three lamps in the induction coil, because I want to ask this question. Mr. Stanley stated, if connections were made between the main conductors we would have 200 volts; in one fig. the terminals of coil e would measure 100 volts, and f, g, h, would measure 50 volts, making a total of 250. Now I would like to ask Mr. Stanley what he would get if he measured the potential between the + conductor and the right hand terminal of lamp, b.

Mr. STANLEY: I have never tried it.

Dr. VAN DER WEYDE at the close of the discussion described some of his early experiments with the induction coil, and exhibited a number of early models, in which attempts are made to completely close the magnetic circuit of the coil. One of these was made with long wires for the core, which wires were then bent over the sides and completely enclosed the coil.

SUBMARINE GULLIES.

IT has been suggested to us that an article which dealt with certain of the many interesting circumstances associated with cable laying and cable repairing would prove of general interest. We have been supplied by Mr. E. March Webb, of the Silvertown Company, with some information with regard to submarine gullies, features which, while fortunately not of very frequent occurrence, sometimes present themselves to submarine telegraph engineers, and believing that the subject deserves every consideration, we do not hesitate to lay that information before our readers.

The chief object in making the following remarks is to call attention to the risks which it seems must necessarily accompany the laying of cables across gullies. As a rule sufficient regard is not paid to the perilous nature of these situations, in spite of abundant evidence at our command as to the dangers present in such localities. Careful soundings will always discover the existence of gullies, and experience, often dearly purchased, proves beyond doubt the serious risk involved by laying cables across them; yet in actual practice it is notorious that these warnings are too frequently neglected.

The questions intimately connected with the subject are of paramount importance to the telegraph engineer, not so much in the fact that the situations referred to are dangerous, for this is a self-evident truth, but with a view to the possibility of some means being found of safely carrying cables across these gullies, since occasions do occur when it becomes expedient, even almost a matter of necessity, to run the risks consequent upon so doing.

In order that such an attempt should prove successful, a study of the natural features generally present in submarine gullies appears to be requisite. It seems also reasonable that the question should be carried still further afield, and the opinions of scientific men be consulted as to the probable origin of these submarine valleys, the physical variations to which they may from time to time be subject, and the cause of such changes—not in one quarter of the globe only, but wherever they may have been discovered, either by ocean research and scientific exploration, or through having been met with in the tracks of submarine cables.

The more experience of this nature which can be collected, the better able will submarine telegraph engineers be, when meeting difficulties of this character, to grasp the situation and grapple with its dangers. Instances have frequently occurred where much time and great expense might have been saved by a quick appreciation of the circumstances, and much subsequent labour might have been avoided by a knowledge of the varying conditions of sea bottoms.

As a step in this direction, we submit to our readers the following notes, trusting that those better qualified than ourselves to discuss the question may be induced to give us some of their experience.

The first case of a submarine gully we would call attention to is that of the so-called "Bottomless Pit" on the Guinea Coast. Although no cable is actually laid across the worst part of this depression, it serves as an excellent example of the dangers of this class to which submarine cables may be exposed.

It is to be remarked from a study of the charts that soundings taken along the coast at intervals of even so little as five miles would have completely missed the dangerous parts, and those acquainted with submarine telegraph work are well aware that only in certain cases, where indications of dangerous ground may have been met with, would soundings be taken along a line of cable at less than ten mile intervals.

In an article on "Land slopes separating continents and ocean basins," which appeared in the *Scottish Geographical Magazine* for May, 1887, Mr. J. Y. Buchanan, F.R.S., says:—

"Along the Guinea Coast as far as Cape St. Paul the 100-fathom line is at an average distance of 15 miles from the shore; and on the south-west coast between the Niger and the Congo it is from 30 to 40 miles from the shore. At three localities there are remarkable exceptions. Off Grand Bassam the 100-fathom line approaches within a quarter of a mile of the shore, and the curving in shorewards of the contour lines produces the very

remarkable submarine gully known by the name of the 'Bottomless Pit.' From the *Buccaneer* five lines of soundings were run across it at distances of two miles between the lines. At one mile from the shore the width of the gully is under a mile, with a depth of 150 fathoms; at eight miles from the shore its width is 1¼ miles, with a maximum observed depth of 327 fathoms; while two miles further seawards its width has increased to four miles, with a maximum observed depth of 452 fathoms. . . . . The bottom consisted everywhere of a soft dark-coloured mud, and the slopes of the sides averaged in many places 2,000 feet per mile. . . . . .

"The 'Bottomless Pit' is situated only 14 miles from the mouth of the large River Akba. As is usual on this coast, behind the beach of pebbles, heaped up and arranged by the combined action of the surf and the prevailing easterly current, there is an extensive lagoon formation connected with the river; and at the point where the 'Bottomless Pit' approaches nearest to the beach, the width of the beach separating the lagoon from the sea is smallest, being little over a quarter of a mile. The mouths of these rivers frequently change their positions, and it is not improbable that the Akba may have entered the sea where the 'Bottomless Pit' now is, and produced similar conditions to those existing at the mouth of the Congo. Since the date of the *Buccaneer's* visit the lagoon at Porto Novo has opened a new communication with the sea.

"Another similar gully occurs to the eastward of Lagos, called 'Avon's Deep,' but it does not reach so close to the shore as the one just described."

We now will deal with the Congo Gully, certainly of the most striking example of a submarine gorge hitherto met with in cable work.

This case differs very much from the "Bottomless Pit," in so far that in the latter there appears to be no continuous gorge, and between the head of the gully and the shore we find a plateau of 19 fathoms; whereas, in the case of the Congo, deep water marks the course of the gully right into the river mouth.

This difference may be explained by the surf on the Grand Bassam coast being very heavy, and the piling up of deposit is consequently great, while off the Congo the surf is light and the river current is enabled to clear away the detritus and silt. This is the more readily understood when it is remembered that the stream of the Congo is always large and constantly flowing; but in the neighbourhood of Grand Bassam, and indeed all along the Guinea coast, the majority of the rivers discharge into lagoons, and only in the wet season does any considerable flow into the sea take place. The strong flood of the Congo also explains why in its neighbourhood the currents running along the coast have less effect in depositing silt along the shore line than is the case at Grand Bassam, where these currents probably assist to a greater degree in the accumulation of mud and sand.

The remarks of Mr. Buchanan on the indraught of sea water as an under current towards the river mouth seem to indicate a point well worthy of consideration. The outward surface current of river water heavily charged with scourings, gradually precipitates this matter on the sides of the gully, while the main channel, according to this hypothesis, is kept clear by the undercurrent. But as both agencies are continually at work, it seems probable that in time the silt deposited on the slopes would accumulate into a considerable, and to a great extent unstable, mass of mud, so light and of so little adherence or consistency, that the undercurrent would find no difficulty in undermining it, and thus bring about the result which was suggested as being the cause of the breaking of the section which connects the island of Sao Thomé with Sao Paulo de Loanda.

This cable crossed the Congo Gully close to its seaward extremity, and passed from 600 to 1,100 fathoms, and then again into 600 fathoms, the distance overground between the two 600 fathoms lines being about 9 miles. These figures must not be considered as indicating the gradient of the slopes, for the depth increases from 750 fathoms to 1,100, in a very short distance.

The cable was laid across the gully in a N.E. direction, at a considerable angle with the axis of the gorge and trending shorewards, as it was thought advisable, for other than technical reasons, to take the cable into comparatively shallow water off Cabinda. The point at which the cable crossed the gully was at a distance of about 65 to 70 miles from the river mouth, the gully rapidly increasing in width, extending, still as a steep-sided ravine, some four or five miles further seawards.

The cable was interrupted at this point a few months after it had been laid. During the repairs, some portion of the cable (about 1·4 N.M.) on the southern side of the break was found to be so deeply buried that its recovery was impossible, and it was suggested that a submarine land slip was the cause of the accident, this opinion being formed from the fact of the burying of the cable and from the condition in which the sheathing wires were found to be in close to the embedded part.

The break may be accounted for in another way. It is known that a layer of extremely soft mud or ooze covers the slopes of the Congo Gully in varying thickness. But underlying this soft matter there exists a bed of comparatively hard clay, which in many places crops out on the surface. As the seawards extremity of the gully is approached the soft deposit seems to increase both in depth and superficial extent. Now it is quite possible that in crossing the gully a portion of the cable might rest on a bed of hard clay, while the length immediately next to it might find itself in a body of the softer mud of unknown depth. That a break under circumstances of this nature could occur is proved by the rupture of the cable off Demerara, which we shall have occasion to refer to later on. To aggravate the position of the cable under these conditions, it must be remembered that after descending a steep incline an equally severe gradient had to be ascended on the other side of the gully, and it was precisely where the cable climbed the opposing slope that it broke.

The cable was diverted in the repairs to within a distance of about 35 miles from the river mouth. It will be observed that Mr. Buchanan gives the maximum depth of the gully in this locality as 573 fathoms. The deepest water was here subsequently found to be about 800 fathoms. This discrepancy is to be accounted for by the fact that during the preliminary surveys the soundings across the gully were taken at intervals of two miles or even more, while on the repairing expedition it was found necessary, in order to obtain correct profiles, to take the soundings at intervals of only half a mile, for the depths varied not only suddenly, but to a very great extent. The cable now crosses the gully at very nearly the position just mentioned. The gorge being here narrower than where the cable originally crossed it, and this might be a disadvantage were not the bottom harder on the slopes as well as in the centre, presumably offering less chances of subsidence as compared with the former position.

As Mr. Buchanan personally superintended a very complete survey of this district, we quote his remarks on the Congo Gully, *in extenso*. The case is a typical one, and may consequently be of special interest to submarine telegraph engineers:—

"The most remarkable feature of this kind occurs at the mouth of the River Congo. Here the gully penetrates inland up the river, a depth of 150 fathoms being found 20 miles within its mouth, while it was traced by the *Buccaneer* to a distance of nearly 100 miles seaward. It forms an immense submarine cañon, with steep mud sides, penetrating deeply into the land. The 100-fathom line runs at a distance of about 35 miles from the coast both north and south of the cañon; the 500-fathom line runs at about 60 miles, and the 1,000-fathom line at about 80 miles from the coast. Of these contour lines, that of 100 fathoms penetrates 20 miles within the coast line, that of 500 reaches to within 10 miles, and that of 1,000 fathoms to within 50 miles of it. At the mouth of the river, off Shark Point, the width of the gully is three miles, and the deepest sounding was 333 fathoms. The deepest sounding obtained in the river, off Banana Creek, was 242 fathoms. Thirty-five miles off the mouth of the river the width of the gully is six miles, and the maximum depth observed was 573 fathoms. The bottom of the cañon is here 3,000 feet below the surface of the plateau in which it is cut.

"It is difficult to furnish a satisfactory explanation of these gullies, but the Congo Cañon is certainly connected with the river which flows over it, and the 'Bottomless Pit' may be connected with the River Akba, which flows into the sea a few miles to the eastward of it. The Congo Cañon is not due to erosion by the river, for the current, strong though it is, does not extend more than 20 fathoms from the surface, and is felt for a considerable distance out to sea, where it thins out considerably. For many miles off the mouth of the river the water has a dark reddish-yellow colour, but this forms only a thin layer, as the ship's propeller turns up the colourless salt water beneath. The existence and the persistence of the cañon are due to an agency which prevents the mud brought down by the river being deposited along its axis. This agency is probably the sea water running up the gulley at the bottom, and returning in the upper layers, mixed with the river water. A circulation in a vertical plane is thus produced, and in the axis of it, settlement of sediment is more difficult than on either side of it. The bottom of the cañon, or gully, would thus resemble more nearly the original form of the bottom of the sea before the Congo discharged its waves into it, than the flatter and shallower bottom on each side of it. In fact, the cañon has been built up, not hollowed out. In how far a crack in the crust of the earth may have had to do with the depth or the position of this cañon, it is impossible to speak certainly, but the preservation and accentuation of it are certainly due to the prevention of the deposition of sediment.

"The nature of the circulation of the water at the mouth of a deep river like the Congo will be better understood if we imagine for a moment a barrier across its mouth at Shark Point, and the whole of the bed of the river above it filled with fresh river water. The depth of the channel, both above and below the barrier, is between 200 and 300 fathoms. On the seaward side the water is salt, with a density of, say, 1·023, as compared with that of the water inside, which is unity; that is, a column of the outside water 1,000 feet high would balance one of the inside water 1,023 feet high. If the barrier be now removed there will be an immediate rush of the denser water inwards to occupy the lower part of the bed of the river, and a rush outwards of the fresh water to occupy the surface layers of the sea outside. If the barrier be now re-established, although it might take some considerable time to clean out the last vestige of salt water from the deepest parts of the inner bed, it would not take long to eliminate enough of the salt water to establish a very decided difference of density on the two sides of the barrier. On its removal again a similar redistribution of the waters would take place, the denser sea water going to the deeper parts of the river bed, and the fresher water going to the surface of the ocean. Now these operations, which we have here imagined to take place *per saltum*, go on continuously in nature. The constant supply of fresh water from the river produces a constant difference between the weight of a column of water at the upper part of its estuary,

and that of an equal column at the lower part of its estuary. This difference may, and probably will, fluctuate in amount, but it will be always in favour of the seaward column, and against the landward one. It finds its natural balance in an undercurrent from the heavier column to the lighter one.

"A very good example of this kind of circulation is afforded by the well known currents of the Bosphorus. These are due to the surplus water, supplied to the Black Sea, by rain and rivers, over that removed by evaporation from its surface, which find its outlet at the Bosphorus into the waters of the Mediterranean. Here the conditions are reversed, the evaporation from the Mediterranean much exceeding the supply by rain and rivers, including that derived from the Black Sea. If a barrier were erected at the Bosphorus so as to admit of the waters on each side attaining their natural density, exactly the same phenomena would be observed on its removal as have been described above when considering the case of the Congo.

"At the Straits of Gibraltar we have a curious instance of a similar phenomenon; here, however, the Atlantic Ocean performs the part of the river, while the Mediterranean is the receiving ocean bed, kept at a constantly lower level by the evaporation from its surface."

On the line of the original direct Spanish cable between the north of Spain and England, and at about 32 miles to the north of Bilbao, is found a depth of 1,500 fathoms. As will be seen from the Admiralty charts, this is the centre and deepest point of a gully which on the south side descends rapidly from 150 fathoms to the depth above mentioned. while on the northern slope the gradient though steep is less severe, the water shoaling to nowhere less than 700 fathoms.

The limits of the dangerous ground may be considered to lie between lat. 43°.35 north and lat. 43°.53 north, the cable having broken no less than four times at distances varying from 27 to 33 miles from Bilbao, the worst part of the bottom having apparently an extent of six miles, nearly due North and South.

The direction of this gully is parallel with the Spanish coast, but the soundings do not show how far it extends in an easterly direction, that is towards the head of the Bay, but they unmistakeably prove the existence off Bilbao of a clearly defined submarine gorge.

On nearly all the repairs a certain amount of cable was lost owing to its being buried, and hence the supposition that the breaks were due to landslips. The ruptures generally occurred in from 900 to 1,400 fathoms on the southern slope, which is the steeper of the two, and consequently the more dangerous.

In certain important points this case is dissimilar to that of the Congo. The head of the Bay where there are several large rivers and where the principal silting must take place, is a long way off. In the neighbourhood of Bilbao there are a few fair-sized streams, but the amount of silt brought down by them could not account for the rapid accumulation on the edges and sides of the gully of deposit in sufficiently large quantities to become dangerous. This view is all the more probable, since the effect of these rivers is felt scarcely beyond their mouths, their carrying capacity being thus very limited. It is therefore scarcely correct to adopt the theory assumed in the case of the Congo, that is, the depositing in large quantities on the slopes of the gully of matter light in consistency and of little adhesion.

If the breaks are caused by the falling in of the slopes consequent upon erosion by an undercurrent, it may be assumed that the same action would go on in other places in the Bay where the same general features were present. Considerably to the north of the locality just referred to, another and deeper gully is found in lat. 44°.45 north, with 1,760 fathoms in its deepest part. The gradient is very steep on the northern side, while on the southern slope the descent is gradual. This gorge lies nearly in the centre of the bay, and from its position and size it might be assumed that the erosive action of the undercurrents would be more accentuated here than in other localities. But so far as we are aware the cable has never been interrupted at this point. Perhaps the undercurrents may be diverted towards the Spanish side and into the gully nearest that coast by the extension into the bay of shallow water to a considerable distance on the French side, whereas on the Spanish shore we find very deep water at no great distance from the coast. It will be seen from the chart that the gradient on the northern side of the deeper gully is very severe, and it is all the more a matter of surprise that no break has occurred here when it is remembered that the cable was laid up this slope, that is from the deeper water towards the shallower.

We quote the following extract from Mr. Buchanan's paper:—

"In Europe, at the head of the Bay of Biscay, and on a coast resembling in some of its physical features the coast of the Gulf of Guinea, a gully or cañon quite like the 'Bottomless Pit' penetrates close up to the shore at Cape Breton, where, in former times, the River Adour entered the sea. This remarkable gully forms a deep indentation in the littoral flat, and runs parallel with the range of the Pyrenees and the mountains of the north coast of Spain. It is not impossible that, in their origin, these two features may have had some connection with each other. Much trouble was experienced with the first cable laid from Bilbao over the deeper part of this gully, indicating some instability in the features of the bottom in this region, even at depths of over 1,000 fathoms. Earthquakes are a frequent cause of rupture of cables in the neighbourhood of the steep slopes connecting the continents with the ocean beds."

It will be observed that Mr. Buchanan does not mention the existence of two gullies, but as a matter of fact, and so far as cable laying is concerned, two distinct gorges are met with in the bay. Whether they are simply incurvings of the deep water, or whether they extend from the head of the bay as continuations of river systems, the soundings taken up to the present fail to show us.

On the Peruvian coast, between Chorillos and Mollendo, a very striking example presents itself of the dangers attending the laying of a cable across gullies.

Unfortunately we have not been able to obtain access to any complete and authentic chart or history of the locality and the repairs, but even the meagre information which we have been able to collect is sufficient to enable us to cite this case as an illustration.

This section has been a peculiarly unfortunate one, for it has failed no less than ten times since 1883, the great majority of the breaks having occurred in the gully now under consideration.

To the southward and eastward of Pescadores Point, the cable between Chorillos and Mollendo repeatedly broke down, and after frequent repairs in very much about the same locality, the cable was eventually taken well inshore, where it seems a more secure bed has been found for it.

During the original laying, the cable, after passing Pescadores Point, was taken shorewards, so as to avoid a sudden jump, as indicated by the soundings, from the plateau of 400 or 500 fathoms on which the cable was being laid, into very deep water, and it was considered that the incurving shorewards, as it appeared, of the deep water would be thus avoided. A line of soundings taken almost at right angles with the coast, showed a gradual descent up to a certain point, but it was discovered later on during the repairs that these soundings happened to be on a ridge separating two deep gorges.

The lines of preliminary soundings taken parallel to the coast were unfortunately too far apart to indicate the perilous nature of the ground, as they happened to strike the level bottom between and on each side of the depressions, and excepting the discovery of the deep water on the intended line of cable, there was not sufficient difference between them to cause alarm.

It is to be remarked that no rivers of any size are found on this portion of the coast, and indeed, the few streams which find their way to the sea are, even at their highest floods, but of small volume, there is consequently no connection, as exists in the Congo case, between a deep river bed and the submarine gully. As in the instance of the "Bottomless Pit" a comparatively level plateau of shoal water is found between the head of the gully and the coast line. On the shore, however, deep gorges cut through the mountains and open out on the very beach; it seems probable, therefore, that some very intimate relation may exist between these gorges and the gully, and that the action of currents and surf, combined with the gradual deposit of matter brought down by the streams assisted by denudation and erosion, have slowly silted up that portion of the gully which, nearest to the beach, at one time probably connected the mountain gorges with their submarine extensions. A curious feature connected with this locality is that on more than one occasion the cable has been recovered, close to where it had broken in 600 to 800 fathoms, so entangled with roots and branches of trees, that it was found impossible to bring the mass in over the bows. We have also been informed that frequently during repairs at this place, quantities of branches and trunks of trees have been noticed drifting past the ship. Now all these trees, both floating and those picked up on the cable, must have come from a great distance, for on no portion of the coast hereabouts is there a vestige of wood or forest.

The breaks may have been caused by the weight of the roots and branches accumulating on some portion of the cable which happened to be suspended; or perhaps this *debris*, collecting on the slopes of the gully and gradually moving downwards, fouled the cable, eventually bringing too much strain on it; or, again, the ruptures may have been due to the slopes of the gorge giving way, either from an overburdening of deposit, or, as has been frequently suggested through earthquakes, thus burying the cable and carrying it with the subsiding matter.

In the numerous repairs effected in this locality, we have been informed that the cable on each occasion has been taken a little further shorewards, but it was not until after the sixth repair that a comparatively safe position was discovered. We presume that the cable now lies in from 400 to 500 fathoms on each side of the gully, and is laid round the head of it in from 200 to 300 fathoms. This at least appears to be the only safe course, for otherwise a most dangerously irregular bottom must have been traversed, and the cable exposed to the same dangers which had already proved fatal in so many instances. A yet better plan would have been, perhaps, to have carried the cable well to seawards of this neighbourhood, thus completely avoiding any part of the dangerous locality.

It seems difficult to reconcile the theory of over accumulation of deposit on the slopes and its subsequent subsidence with the facts of the case as a means of accounting for the repeated breaks. No river of any size discharges here, in fact, during a greater part of the year the few streams in the neighbourhood cease to flow. For this reason also the theory of an indraught as an undercurrent (*vide* Congo Gully) cannot be adduced in connection with the subsidence of the slopes.

The deposit in this spot of roots and branches of trees by the coast current may be caused by the formation of the bottom which possibly produces a back water where the *debris* would accumulate and sink. One of the breaks at all events was attributed, and probably justly, to this circumstance.

It is possible, though not very probable, that the bottom of this place is continually changing from the washing away of the slopes by the coast current, but this certainly appears to be a theory founded on too fortuitous a base to be seriously considered. Perhaps the earthquake version may be credited as possessing a more reasonable foundation.

An argument which seems to discourage most of the foregoing hypotheses, lies in the fact of the majority of the breaks off at Pescadores occurring at very short intervals, most of them taking place between the months of February and April, 1884. In 1883 there were two breaks, we believe, in this neighbourhood, but prior to that, years had elapsed without an accident to the cable at this place, and since 1884 we understand there have been no breaks here.

The evidence we have proves that the greater number of the breaks were accompanied with the burying of the cable in mud and clay. Now to break the cable would necessitate no inconsiderable mass of material changing its position, and the question naturally arises why should the agency, whatever it may have been which caused these changes, have come so suddenly into being? Here indeed is the strongest argument adduced for the earthquake theory, but it is a dangerous reasoning, inasmuch as it is such an easy mode of settling the difficulty, a *Deus ex Machina* too readily accessible.

It is generally the practice in the preliminary survey of a cable route which follows a coast line to take soundings at certain intervals parallel to the coast with occasional profiles at right angles to the line, so as to obtain the gradient of the seaward slope. No doubt this latter information is requisite, but the case of the Pescadores Gully points emphatically to the absolute necessity of a very careful watch being kept on the changing features of the coast during the surveying operations, and to the fact that the soundings along the line of cable are of far more importance than those at right angles to it, interesting as the latter may be.

Of the cases which we are able to quote none appear to resemble the Congo Gully so closely as the gorge off the Rovuma River, though on a much smaller scale. The cable between Mozambique and Zanzibar has broken down some seven or eight times at this particular spot.

The information at our disposal is, unfortunately, insufficient to enable us to arrive at any very accurate conclusion. There appears little reason, however, judging from the general nature of the locality, to doubt that the disturbing influences at work here are probably the same as occur in the case of the Congo, and we should probably find, were complete details at our command, that the same general features are present in both circumstances. In the present instance there is not, of course, the same volume of water as discharged by the Congo, nor can there be the same amount of silt deposited, nor is this gully equal in depth or in extent to its west coast congener.

The curious point about the breaks off the Rovuma river is that they are coincident with the rains, a feature which we have not yet had time to observe in the Congo. One can hardly conceive that the floods would deposit in so short a space of time (the intervals being only a year) an amount of silt sufficient to form a dangerously unstable mass on the sides of the gully, nor can we admit that the river current even in the wet seasons reaches deep enough to disturb the bottom.

It may be very plausibly argued, however, that the rains produce an enormous increase in volume and strength of current in the river, and consequently the in-draught of sea water as an under current is proportionately augmented at these seasons; increased, in fact, to such an extent as to materially affect the sides of the gully.

If the breaks in the cable are due to the falling in or subsidence of the sides of the gully, what enormous changes must be taking place in the formation of the bottom! It would seem impossible that any clearly defined gully could still exist, for these landslips cannot be said to have commenced with the advent of the cable, and the process of the reduction of the slopes would naturally tend towards the widening of the gully and the decrease in the gradients of its sides.

This case brings into strong relief the futility of relaying cables over ground already proven to be dangerous, the results being an excellent parallel to the repeated disasters which befell the cable off Pescadore Point.

Between Demerara and Trinidad the cable lies in shallow water on a very level bed of extremely soft mud. No indication of any abrupt changes of depth occur throughout the whole extent of the shallow plateau which, running parallel with the coast, between the points mentioned, has a breadth in a seawards direction of some 40 miles.

It may be asked, what connection has a bottom of this description with the cases under consideration, but it will be seen that perhaps an intimate relationship exists, and the bare possibility of a similarity is sufficient excuse for mentioning this particular instance.

No bottom could apparently be better adapted or more suited to the longevity of a cable than this, but the cable broke near Georgetown, off the mouth of the river Essequibo; we should say estuary rather than "river," for it is but a channel conveying to the sea the waters of three fairly large rivers which meet not many miles from the coast, partaking consequently somewhat of the nature of a gorge or ravine, cut down through the adjacent low lying country. Perhaps some convulsion at an earlier epoch may have formed, or assisted to form, this channel.

When the cable was repaired, it was found that on one side of the break the cable was lying on very hard clay, while on the other side the bottom was composed of the softest mud it can be possible to imagine.

Now whether a gully originally existed here as a continuation of the estuary above referred to, and of which the clay formed one of the slopes, or whether this hard bottom was simply a reef running out amid the surrounding soft deposit, does not much matter. The conclusion arrived at must be the same in either case. The cable lying on the surface of the hard clay would on leaving it sink to a considerable depth in the softer matter from its own gravity. As time went on, this soft deposit gradually sinking and consolidating would slowly and to a certain limit carry the cable with it. More silt deposited by the river would accumulate and take the place of the already compressed matter, till at last the weight of the superincumbent mass would prove too great a strain for the cable to withstand, since there would be no corresponding sinking of the cable in that portion of it laid over the harder ground.

This seems the only reasonable hypothesis to adopt, for here there is no question of the cable being suspended from a steep slope, no suggestion of a gully whose sides possess an unfortunate habit of falling in, no appearance of branches or roots accumulated round the cable. A gully may certainly have at one time existed, but filled up in course of time with mud of light specific gravity, the gradual compression of which may have considerably modified the original slopes. The absence of any strong inshore current would assist towards the depositing close to the river mouth most of the silt brought down.

In attempting to arrive at some conclusion, based upon the evidence collected in the preceding pages, and while seeking to apply the history of interruptions to cables in ocean gullies to the profit of submarine telegraph engineering, several points seem to be brought into very prominent relief. Among those which appear to us as most worthy of consideration are:—

(*a*) A rupture of the cable inevitably follows upon its being laid across a gully.

In support of this argument the evidence we have as to the various ruptures seems sufficient. We could, however, quote in addition, the case of the section between Coquimbo and Valparaiso on the west coast of South America, where the cable broke on several occasions off the Limari River. Here the mountain ranges which border the coast are divided by a deep gorge, or valley, through which flows the river, a fairly large stream. No doubt circumstances analogous to those extant in the case of the Pescadores Gully, combined with some of the features met with off the Congo, were encountered in this locality. Another instance is that of the break in the Direct United States Atlantic Cable, where it crossed the Faraday Hills, between them meeting with an extremely steep-sided and narrow gorge of considerable depth; the conditions being in many respects similar to those accompanying the gullies previously mentioned.

(*b*) A cable once having broken in a gully, it is absolutely necessary, in the repairs, to relay it altogether beyond the limits of the dangerous sphere and to rigidly avoid the temporising so frequently indulged in.

The repeated disasters attendant upon relaying the cables across the gullies in the Bay of Biscay, off Pescadores Point, and off the Rovuma River, are instances sufficient to emphasise the truth of this statement. The temporising we refer to is the patching up of a section by a hasty repair, the only object being the restoration of telegraphic communication with a minimum expenditure of time and cable. The result of such a repair may certainly be that the traffic is only momentarily suspended, and but a trifling amount of cable employed, but the fact is overlooked that under these conditions another repair within a short interval of time will probably be unavoidable. By a careful consideration of the question it will be found that the expenditure consequent upon repeated repairs, and the losses involved through frequent interruptions to the traffic, must largely exceed the disbursements resulting from a thorough and systematic procedure upon the first occasion of a rupture. No censure should attend a little delay, or an apparently too liberal employment of cable, when the result obtained is the selection of a position which, so far as experience can determine, assures safety and security for the cable.

(*c*) Once that a dangerous place, that is, ground presenting abnormal features, has been met with, either during the preliminary surveys, or during the laying of a cable, or upon the occasion of any repairs, no pains should be spared, no expense abstained from, in carefully and elaborately surveying the locality.

The grounds upon which this statement is made are self-evident. It can hardly be supposed that had careful soundings been executed in some of those localities to which we have referred, the cables would have been originally laid, or, at all events, subsequently relaid, across such extremely dangerous positions.

(*d*) In surveying a bottom where steep gradients and frequent irregularities are met with, or may be expected to occur, the soundings should be taken at intervals of half a mile, certainly not farther apart than three-quarters of a mile, and, indeed, there is no difficulty attached to sounding at still closer intervals where buoys have been carefully laid down before commencing the sounding work. Instances, too numerous to recapitulate, show the importance of soundings, over doubtful bottoms, being taken close together, more especially with regard to those made on the actual or proposed line of cable. Two cases we have cited,

namely, the Pescadores and Congo gullies, particularly illustrate the possibility of serious errors being made in computing the gradients and estimating the character of the bottom, even with soundings taken only two miles apart.

(*e*) While we have plenty of evidence to show that steep gradients when met with in the sides of a narrow gorge or gully, are fatal to the safety of a cable, on the other hand, proofs are not wanting that a single precipitous slope is in no way to be dreaded when the proper precautions as to speed and slack are adopted, and the cable laid down hill, that is, in the direction of the downward slope. The proof of this, and also as demonstrating the satisfactory results arrived at in laying cables over difficult ground, after exceedingly careful preliminary soundings, we need only cite, among many which present themselves to us, the cases of the Canary Islands, the Cape de Verd Islands, and the coast near Habana. At all these points the seaward slopes are extremely abrupt, and though most of the physical conditions present are apparently exceedingly unfavourable to the life of cables, no interruptions due to the steep gradients have as yet occurred in these localities, although the cables laid there have been down sufficiently long to be affected had they been less carefully laid. Instances bearing out this assumption might be almost indefinitely repeated.

As to the causes of the breaks referred to in the foregoing remarks, we can, in the majority of cases, only theorise. We know that the ocean bed in many cases has a surface similar to Alpine regions, that undercurrents are met with, that landslips occur, that deposit and silt collect, that slopes gradually subside, that floods aggravate many of these forces, and that earthquakes are not infrequent; we are also pretty certain as to the ultimate fate of suspended cables, but beyond these well-known features we are unfortunately compelled to take *omne ignotum pro mirabilu*.

In conclusion, we may observe that it is a matter for regret that complete details of repairs to ruptured cables are seldom, if ever, published. There appears to exist a certain hesitation as to imparting information on this subject, as if the publication of these details might be of prejudice to the company whose cables may have broken, or to the engineers who may have undertaken the repairs.

It is evident that the most interesting and valuable knowledge might be acquired from the study of the varying conditions under which cables have broken, and the difficulties overcome in repairing them, but it is unfortunately the custom to keep these details secret, a practice evidently detrimental to the acquisition of scientific knowledge on subjects of interest to the students of natural phenomena as well as to telegraph engineers.

NEW PATENTS—1888.

2002. "A new electrical tool." T. THORP. Dated February 10.

2073. "An improved electric alarm apparatus." A. C. IWANOWSKI. Dated February 11.

2088. "Improvements in dynamometers." J. G. GILCHRIST. Dated February 11.

2125. "An improved method of constructing and regulating arc lamps." W. ROWBOTHAM. Dated February 11.

2130. "Improvements relating to electric telegraphs." A. MUIRHEAD. Dated February 11.

2170. "Improvements in bases and covers of switches or cut-outs used in electric lighting." F. W. WHITE. Dated February 13.

2178. "Improvements in plates for secondary batteries." R. N. BOYD. Dated February 13.

2179. "Electric lights." M. WHEELER. Dated February 13. (*Complete.*)

2235. "Improvements in or applicable to electric conductors." J. A. BEYCE. Dated February 14.

2239. "An improved electrical door and window contact." J. T. MAYFIELD, J. T. TODMAN. Dated February 14.

2246. "Improvements relating to dynamo-electric machines." H. H. LAKE. (Communicated by R. Eickemeyer, United States.) Dated February 14. (*Complete.*)

2250. "Improvements in printing telegraphs." J. H. LINVILLE. Dated February 14. (*Complete.*)

2251. "Improvements in switches for electric circuits." A. GRAHAM. Dated February 14.

2259. "Improvements in thermo-electric and furnace batteries." H. MESTERN. Dated February 14.

2304. "Improvements in fireproof batten lights for electrically lighting the stages of theatres and other similar buildings." S. SUDWORTH, E. L. BERRY. Dated February 15.

2308. "Improvements relating to dynamo-electric machines." C. COERPER. Dated February 15. (*Complete.*)

2313. "Improvements in dynamo-electrical machines and apparatus used in connection therewith." S. Z. DE FERRANTI. Dated February 15.

2314. "Improvements in electrical safety fuses." S. Z. DE FERRANTI. Dated February 15.

2315. "Improvements in electrical mains." S. Z. DE FERRANTI. Dated February 15.

2316. "Improvements in dynamo-electrical machines and apparatus used in connection therewith." S. Z. DE FERRANTI. Dated February 15.

2320. "An improved arc lamp clutch." S. P. BLACKMORE. Dated February 16.

2369. "An improved system of electrical or other signalling between signal cabin and driver and guard in charge of railway trains in motion or otherwise, and apparatus therefor." J. ORME. Dated February 16.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

12032. "Improvements in electric incandescent lamps." A. FEATHERSTONHAUGH. Dated September 22. 8d. The inventor places in the glass globe of the lamp two or more filaments or two or more wires, as the case may be, side by side and close together, so that the heat from each reinforces that from the other, and there is less loss by radiation. There is 1 claim.

15344. "Automatic switch and governor for electric lighting purposes." A. M. CLARK. (A communication from abroad by the Electrotechnische Fabrik Cannstatt, of Cannstatt, Germany.) Dated November 24. 8d. Claims:—1. A regulator for lighting with accumulators and dynamo, consisting of a fine wire solenoid in parallel with the accumulators, and which, when the maximum safety tension of the lamp current is exceeded, switches corresponding resistances into the lamp circuit, substantially as described. 2. For the purpose of the automatic switching off and on of the connection between the shunt-wound dynamo and the charged accumulator, the arrangement of an electro-magnet or of a solenoid figure with a duplex coil, of which one is switched to the magnet current and the other to the main current which directly influences the electro-magnet or solenoid, so that the latter by the action of the machine with the help of the attracted armatures or cores closes the connection between the machine and the accumulator to be charged, and breaks the same as soon as the machine is stopped.

16109. "Improvements in miners' electric safety lamps." S. F. WALKER. Dated December 9. 8d. Claims:—1. The arrangement of a primary battery within an outer containing vessel, the outer containing vessels of the cells themselves forming one element of the galvanic couple, and the said vessels forming sections of a cylinder or other convenient form, substantially as described. 2. The arrangement of the incandescent lamp fitted to the cover, with an outer protecting glass, substantially as described. 3. The arrangement for completing the connections between the lamp and the cells, at the same time excluding the surrounding atmosphere by causing the force exerted in placing the cover of the containing vessel in its place, to overcome the tension of springs placed for the purpose of making connections, substantially as described. 4. The arrangement of lamp, reflector and lens as described.

16650. "Improvements in electric apparatus for the control of watchmen." O. SKRIVAN and F. DVORAK. Dated December 18. 8d. Consists in the application of an improved controlling clock, improved dials in electric communication with such controlling clock; and an improved arrangement of electric bell, in combination with a normal clock and switch. The claims are 4 in number.

1887.

551. "A method and apparatus for protecting telegraph wires from injury during snowstorms." H. J. NEWCOME. Dated January 13. 4d. Claim:—The possibility of preventing the destruction of telegraph and telephone posts and wires during snowstorms accompanied by high winds by removing the snow before it freezes by means of an apparatus or frame which is made by a cord to travel along the wires, and at no other time to be in contact with them, and which may be used by any person on the darkest and stormiest night without injury to the wires.

5735. "An apparatus for the administration of electricity to the human body in Turkish baths." M. HUMM. Dated April 20. 6d. Claim:—An apparatus so constructed and attached to a chair and fitted with flexible electrodes, in such a manner that the operator can administer electricity to any person sitting in the chair and to any part of the body. The apparatus and chair to be used especially in Turkish, lamp, or vapour baths. The electricity to be used as a curative power in the manner set forth in patents No. 11,224, A.D., 1885, and No. 265, A.D. 1884.

6869. "Improvements in and relating to primary and secondary batteries." H. H. LAKE. (Communicated from abroad by W. I. Ludlow of America.) Dated May 10. 8d. The inventor causes a penetration of the electrolytic or exciting fluid into the pores or cavities of the electrodes, by placing the latter in a closed cell or jar, which can be hermetically sealed, and in which a vacuum is created for allowing the electrolyte to penetrate the body or interior of the electrodes, or pneumatic or hydraulic pressure is exerted for attaining a similar result, either separately or in connection with the vacuum. The claims are 12 in number.

6928. "A compound for covering electric wires." H. W. MERRITT. Dated May 11. 4d. Claim:—The compound consisting of quick lime, fir balsam, asbestos, sugar, oxalic acid and water compounded, substantially as described and for the purpose set forth.

7953. "Improvements in electric signalling apparatus." G. CONZ. Dated June 1. 6d. Claims:—1. The combination of a number of conductors arranged in a concentric or equivalent manner a series of contacts, each connected electrically with a certain combination of said conductors, and a key or switch capable of being placed in contact with any one of said contacts, substantially as set forth. 2. A series of conductors having contacts for simultaneous passage of electric current through a greater or less number of said conductors in combination with a series of resistance coils, substantially as and for the purpose set forth.

8950. "Improvements in connections for electrical conductors." R. O. RITCHIE. Dated June 23. 8d. In a base of any desired shape or configuration, made preferably of porcelain, or baked earthenware, though any other suitable insulating material may be employed, there are formed grooves or channels for the wires or leads to lie in, and at a distance from each end of these grooves or channels, coinciding with the positions that would be occupied by the usual terminals, suitable holes or recesses are made. These holes or recesses are carried down for such a distance only as to ensure their not passing through the base, and they are so made as to extend conically inwards. These conical holes are filled in with any suitable metal, or metallic alloy, the same being melted and run into the holes until they are quite full. If now any wire, which it is desired should terminate on the base, has its end bent at approximately a right angle, so as to form a hook-like projection, having a length slightly less than the depth of the hole or recess, then on allowing the point of a hot solder-iron or the flame of a blow-lamp, or other convenient source of heat, to act on the metallic plug in the hole or recess for a sufficient length of time to melt it, the hook-like projection may be inserted in the hole or recess, and being retained there until the metal cools it will then be found to be firmly retained in place. The claims are 4 in number.

CORRESPONDENCE.

Criticisms.

After reading and re-reading with all attention the article on the "Safety of Theatres," to which are appended the initials "W. T. A. B.," I fail completely to appreciate the *raison d'être* of the said effusion, or, in plain English, I am unable to perceive what its anonymous author is "driving at." Why those two long columns of sentimentalism and horror on stilts? Who is to be terrified by the *épouvantail* thus strangely patched up, and who thereby frightened into an admiration of electricity as an illuminant in the Temples of Thespis? Not, I should fancy, the readers of this REVIEW, who, being either electricians or at least admirers of the electric light, have no need of being convinced of the general sublimity of things electrical, whilst the "public" does not read the technical journals. It seems, therefore, to my feeble intelligence that "W. T. A. B's." little *danse maccabre* falls flat. Truly it is a strange idea to commence an article by a dissertation on the dangers to the bodies which we probably possess and to the souls of which we are destitute, incurred by visiting a dramatic representation, and to wind up with a description of a Teutonic system of theatre construction.

Respectfully would I suggest to "W. T. A. B." that he might have produced a far more tragic effect had he chosen the destruction of the *Opéra Comique* as a theme for his dramatic and blood-curdling periods. He would have had at his disposal a vaster supply of "blackened corpses," headless bodies, and bodiless heads on which to exercise his literary talents. Moreover—a great advantage from the dramatic point of view—the event in question had cast its shadow before it a long way ahead. Did not the Deputy Steenackers call attention to the danger, and, like Cassandra, get laughed down for his pains? Berthelot, while mocking the interest shown by the Deputy in such insignificant beings as *figurantes* and upper-gallery spectators, admitted that, according to the statistics of theatre fires, the Salle Favart *ought* shortly to burn down. Talazac had a rope ladder in his *loge* to favour an escape by the window when the expected fire should break out. Most of the actors seem to have discussed and anticipated the possibility of a catastrophe, even a certain narrow bridge of highly inflammable materials which united the upper stories of the building had been named by them *Le pont de Mahomet*, a grim allusion to the "bridge of breath" which spans the oriental φλεγεθων, the Al-Sirât familiar to all readers of Byron—

> "Though on Al-Sirât's arch I stood,
> Which totters o'er the fiery flood," &c.

Let us add to this a host of personal "presentiments," and it will be seen that "W. T. A. B." has missed an opportunity of serving us up a *dish* certainly more astounding and perhaps even more ghoul-like than that fabricated by him from the remains of the Exeter "holocaust," as that gentleman classically puts it.

Perhaps, however, the anonymous one did not like to lose the fine opportunity of introducing two highly dramatic scenes into his recital of the exploits of the "madly rushing Fire Fiend" (!) namely, that of the author as a sort of coffee-room Belshazzar, the newspaper heading replacing the "writing on the wall" of the biblical myth; and further on the dramatic incident of the classical 'Ανάγκη under a friendly form holding one of "W. T. A. B's." brethren back from annihilation by the coat-tail!

Let it not be supposed that I desire to treat lightly or to mock the horrors of theatre fires. My cynicism does not go quite so far. If one were sure of being asphyxiated first and subsequently incinerated, a halo of mystic terror would surround such a "leap through flame into the future," but it unfortunately happens that the majority of the victims are first crushed and then half burnt, afterwards being inundated with water and finally dug out of the ruins for "Christian burial," presenting an inartistic resemblance to gone-wrong pancakes, overdone *beignets soufflés*, or other carbonised or semi-carbonised organic matter, thereby rendering such a finale supremely inelegant and undesirable.

In the same number of the REVIEW I notice a series of "Notes" culled by Mr. B. H. Collins during a tour to various European cities, which are certainly open to criticism.

To show the careless way in which the information therein contained has been collected, it suffices to analyse the paragraph on the lighting of Paris.

Without remarking on the strangeness of Mr. Collins's idea that in eight lines one can *resumé* all all that has been done here in the way of electric lighting, I would point out to that gentleman that I have never seen the Jablochkoff lights referred to, and that on the occasion of my last visit to the Louvre the old horizontal carbon regulators of *de Mersanne* were still hanging in their old places on *la Place du Carrousal*, just as they have done these many years. Can it be that Mr. Collins is so shortsighted as to be unable to distinguish a regulator from a Jablochkoff candle? As regards the electric lighting of *la Place de la Concorde*, I may state that it exists solely in Mr. C.'s imaginative cranium-lining.

Moreover, it would be pleasing to know what the author of the "Notes" means by "the new theatre named Opera," of which the electrical installation "forms a great attraction?" If the ridiculous bastard renaissance building of Garnier is meant, it is annoying to see this monument of the hideous taste of the second Empire referred to as a "new theatre." L'Opéra is hardly new, and certainly its aspect could not have deceived Mr. Collins, since time, dust and bad weather have spread over its pink and white glories a uniform tint of dirty grey.

Verily, if all the "Notes" have been compiled in this fashion, as would seem likely, very little reliance can be placed in them. I might cite other curious phrases which do not speak for their author's linguistic attainments, but as carping is silly I refrain from so doing. I will solely remark, anent the candles on the high altar, that they are likely to "hold their sway" for some time yet, for the reason that in the Catholic Church, for altar lighting purposes, candles alone are considered as acceptable to "*le nomme Dieu*."

My last week's letter contains some frightful typographical errors. For example, the first line of the 7th paragraph should have been: "So much for the misrepresentations of the *past*."

Further on the sense is knocked out of half a paragraph by means of two well placed misprints. The mutilated periods should read :—"It might be supposed that 'arc-ette *was intended* to rhyme with 'coquette,' a poetical method of expressing the instability of the thing. This is not the case, the termination 'ette' is supposed to express," &c.

The "comp" is evidently not yet accustomed to my caligraphy, which is, by-the-way, not at all καλὸς, but rather hieroglyphical.

F. de Wolffers.

Paris.

[We hold our "comps" blameless in the matter of M. de Wolffers's "hieroglyphical caligraphy." A goodly portion of his last—shall we incur his disdain if we say "effusion"? well, his last epistle, was perforce eliminated for the very sufficient reason that no member of our staff could decipher some of its phrases. It is clear enough, after his explanation, what he *meant* to write in the instances of error which he points out; it is not so clear, though, even now, what he actually did write.—EDS. ELEC. REV.]

Ship's Compasses.

I am desirous of fixing a compass in a cabin in the centre of a swing bridge, but at present any compass so fixed turns round with the bridge. Not only is the bridge of iron, but there are several levers and pipes, not by any means symmetrically grouped, in the cabin. I have tried placing the compass in a turned block of wrought iron, but find the needle points to one spot which, I take it, proves that the shield is not homogeneous.

Would any of the readers of "ours" kindly show me how to correct the compass, or give me the title of any good work on the subject.

E. de M. Malan.

February 20th, 1888.

[Either Mr. Bottomley or Mr. Gray could doubtless give the information desired in very few words.—EDS. ELEC. REV.]

Correction for the Length of the Needle of the Tangent Galvanometer.

After some trouble I have at length succeeded in putting my hands on the papers of Dr. Joule and Prof. Jack in the Proceedings of the Manchester Philosophical Society to which reference has been made; and for the benefit of those who might possibly desire to consult them I may mention, in amplification of Mr. Kempe's reference, that the date is 1867. Dr. Joule does not say how he obtained his formula. There is little doubt, however, but that it is merely the second term of a well known expansion which Prof. Jack in his first paper (a sequel to that of Dr. Joule) refers to Wiedemann's *Galvanismus*. This series is given in substantially the same form by Mascart and Joubert, section 736 *et seq.* If we have here the genesis of Dr. Joule's formula, then as printed, and as reprinted by Mr. Kempe in his excellent book, it clearly requires to be affected by the numeric $\frac{3}{4}$. Prof. Jack, at page 147 of the volume in question, gives the first correction term as

$$\frac{\rho^3 \, E}{2 \, \pi \, r^2} \tan \alpha \, \frac{3}{4} \frac{l^2}{\rho^4} (4 \, e^2 - r^2) (1 - 5 \sin^2 \alpha)$$

which in Mr. Moon's notation becomes

$$\frac{R \, H}{2 \, \pi} \tan \theta \, \frac{3}{4} \left(\frac{r}{R}\right)^2 (5 \sin^2 \theta - 1)$$

or exactly as given by me at p. 182 of the REVIEW.

Mr. Moon's remarks about the Post Office method of testing E.M.F. of batteries are very interesting. If borne out by experiment they would seem to point to the propriety of adopting, for the sake of consistency, some zero or differential method.

A. C. Elliott.

Edinburgh, *February 21st*, 1888.

Transformer Literature.

The papers by Kapp and Mackenzie on the subject of transformers are of interest to everyone in the electrical line of business at the present moment; Mr. Kapp's paper is well worth the closest study by all students, and is a very valuable contribution brought forward at the right time.

This paper shows that there is nothing new in transformers of recent design. The only difference existing between the various forms mentioned by Mr. Kapp appears to be in the different forms of sheet iron stampings made to form the magnetic shell.

The paper by Mr. Mackenzie is a very extraordinary production to bring before a scientific society at this time of day. The polar or Ruhmkorff transformer has been discarded and ought to be buried with the famous tuning fork dynamo; at any rate, it does not come within the range of discussion in practical work. The whole paper appears to be a piece of special pleading for the claims of M. Gaulard's party to priority of invention.

I have before now in this journal referred to specifications according to which any electrician may work a series system of distribution quite as successfully as he could work the same system by the specifications of Gaulard and Gibbs, and at least eight of these specifications date some years prior to Gaulard and Gibbs's patents.

The distribution patents granted to Gaulard and Gibbs in 1882 do not show how to operate the series system in any manner or detail better than the prior patents, and all the patents granted then for transformers, with the exception of very recent ones, are for improvements in the Ruhmkorff type; Mr. Mackenzie admits both the series system and Ruhmkorff transformers are dead failures.

Now, who invented the happy combination of the parallel system with the nonpolar transformer? a combination which has led to all the success of transformer distribution. Surely when such a combination meant success where miserable failure was the rule prior to its discovery, it is worth while settling the question as to who made it. I have heard it said that such a combination was no invention at all, but the fact that it succeeds where every prior combination failed is proof to me that there was some invention in it, and those parties now imagining themselves secure under old patents and licensed under old patents, may find that out to their cost. Of course all this contention is to be deplored; the grabbing policy pursued by foreign inventors and speculative companies in London has done more to impede progress in electric lighting than all other causes combined together, the Electric Lighting Act included.

Mr. Mackenzie lays down four essential features in the construction of transformers according to Gaulard and Gibbs's ideas. These features may be important to the special system referred to, but I for one do not consider them of the slightest importance; in fact, the first feature referred to is altogether a mistake, in the parallel system.

The essential features in a transformer, such as is used in every successful application, are :—

1. The balancing of the main pressure by the counter pressure of the primary circuit in the transformer.

2. The formation of a perfectly closed magnetic circuit about the primary and secondary coils.

These two features are not contemplated in any specification or writing by M. Gaulard up to date within my knowledge.

The question as to which is the best transformer is easily settled : a shell transformer proportioned on the lines elucidated by Mr. Kapp in his valuable papers.

The low-pressure dynamo, combined with a main transformer, has been in use regularly over a circuit of 1½ miles in Glasgow for over a year now, lighting two public shops.

The three-wire systems have been thoroughly tested at Cathcart, and other developments of importance have been worked out practically, accounts of which are shortly to be published.

The patents claiming and describing the main transformer and three-wire systems of distribution are No. 15,545, 1886, and No. 16,326, 1886.

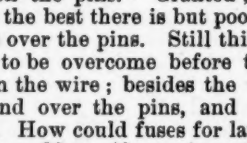
In conclusion, I may say that I always admired the determined perseverance of M. Gaulard with his transformer ideas. Such perseverance is commendable; but perseverance is not invention.

Rankin Kennedy.

February 20th, 1888.

Safety Fuses.

I must apologise for taking up your valuable space but your correspondent of last week evidently knows but little of the subject upon which he writes, or he would know better than to advocate additional loose contacts in an electric light circuit. The form of Thomson's fuse he describes is, I think, well known, and needs but little explanation. It is also clear that a wire (through which the current has to pass) depending for its contact on the mere friction of a portion of its round surface, against an equally small portion of a round pin (without saying anything of dirt and oxidisation of such contact surface), cannot even for small currents be a good form of contact, and must in itself tend to uncertain heating, the very thing that one ought to guard against. He says that "the *two* ends of the fuse wire are loaded with weights, so as to strain the part beween the pins." Granted; but as I have shown, even at the best there is but poor contact where the wire passes over the pins. Still this small amount of friction has to be overcome before the weight can act promptly on the wire; besides the wire would be too stiff to bend over the pins, and the precaution becomes futile. How could fuses for large or moderate currents, say even 30 or 40 ampères, be arranged on this principle? how much contact surface at pins would be required, and how big the weights? In the fuse I advocate (as shown by fig.) special care is taken to provide *large* contact surfaces and *rigid* fixing of fuse wire at *both* ends. Fuse wire itself being made of easily *fusible* metal, and to carry *all* the load.



The weight hangs *between* the points of suspension, and free to act by force of gravity. Unfortunately the copper and silver wires tried *by me* always got red-hot before fusing, but your correspondent seems to prefer complications, bad contacts, and the chance of red-hot wires to simplicity, good contact, and impossibility of wire becoming red-hot, to say nothing of certainty of action.

In reply to the latter part of his letter, I did not say the tension wire used in Thomson's fuse was *not* a new idea. This was an error of the reporters, and I pointed it out to the editors of the ELECTRICAL REVIEW. I would suggest that your correspondent reads my reply when published in the *Journal* of the Society of Telegraph Engineers, also the paper itself, which appeared in the last No. of the *Journal*, from which he will be able to see the difference between *my* fuse and any that have preceded my invention. That I have tried springs and not found them answer satisfactorily is quite true, and is *fully* explained in my reply before the Society. Had your correspondent not chosen to hide his identity under a *nom de plume* (Electrophile), I should have had much pleasure in sending him a copy of my patent, which, although he mentions it, he appears not to have read.

Arthur C. Cockburn, *M.S.T.E., F.C.S.*

Safety Devices.

I am sorry to see you have reproduced a statement which appeared in the proof of Mr. Kapp's paper, which he kindly suppressed at my desire in the paper itself as read, viz., that my safety device had been tried at the Grosvenor Gallery installation. From this it would appear that the apparatus had been practically in use there, which is not the case, as it was only finished in time for Mr. Kapp's paper.

A rough experimental apparatus was tried by the kindness of the electrician of the Grosvenor Gallery in his test room and worked as stated, but I had, of course, no intention to allow this to appear in print, and corrected it as soon as I saw it.

I shall be much obliged if you will kindly insert this correction.

P. Cardew.

February 19th, 1888.

Dynamo Connecting.

Will any of your readers kindly state at what time they first knew of the principle of connecting up two or more compound or series dynamos in parallel as applied by Gramme and Mordey, and described in "Thompson's Dynamo Electric Machinery," pages 335—340?

Enquirer.

Boston, Mass., *January 30th*, 1888.

[We will leave our readers to answer the precise question asked, but at the same time, we may say that about 12—13 years ago in some lighthouse experiments at the North or South Foreland two Gramme machines of the original type were used in parallel for producing the current. It must be remembered, however, that these machines had each three armatures, two joined up in parallel for producing the working current, and the third connected with the field magnets for exciting and keeping up a magnetic field, no matter what happened to the external circuit.—EDS. ELEC. REV.]

Exhibiting Inventions at Exhibitions.

Referring to the notice in your issue of last Saturday respecting the Glasgow Exhibition, and in view of the several other exhibitions to be held this year in Belgium, Vienna, Munich, Melbourne, and elsewhere, will you kindly allow us through the medium of your space to caution inventors against the danger of exhibiting unpatented inventions under Section 39 of the recent Patent Amendments Act.

This section is one of the most misleading character, for while it purports to protect the invention during the exhibition, and to secure to the inventor unprejudiced rights against others, it now transpires by recent decisions in the Law Courts that the legal interpretation of the section is that it merely affords protection to the inventor as against *his own* acts, and that he is not protected against others copying, if they choose, his invention. According to this interpretation then, it is injudicious for any inventor to exhibit under the section in question, for while he no doubt acquires protection against the consequences of *his own* acts, he is simply exposing his invention for unscruplous speculators to pirate, and probably deprive him of any benefits he may be entitled to in connection therewith.

The remedy is, not to exhibit without first taking out provisional protection, a step which affords all the security desirable under the Patent Law.

J. K. Fahie & Son.

February 30th, 1888.